STIC Search Report
EIC 2600

USPTO

STIC Database Tracking Number: 119046

TO: Scott Wallace
Location: PK2 6B03
Art Unit: 2671
Thursday, April 08, 2004

Case Serial Number:

From: Pamela Reynolds
Location: EIC 2600
PK2-3C03
Phone: 306-0255

Pamela.Reynolds@uspto.gov

Search Notes

Dear Scott Wallace,

Please find attached the search results for MAYA.
I did not find any item mentioning specifically version 2.0
I did attach an IEEE and ACM article on MAYA. One is by the developers.

If you need anything else please let me know.

Thank you.

Pamela Reynolds

sira
Search and Information Resources Administration

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File   9:Business & Industry(R) Jul/1994-2004/Apr 07
         (c) 2004  The Gale Group
File  15:ABI/Inform(R) 1971-2004/Apr 07
         (c) 2004 ProQuest Info&Learning
File  16:Gale Group PROMT(R) 1990-2004/Apr 08
         (c) 2004 The Gale Group
File  20:Dialog Global Reporter 1997-2004/Apr 08
         (c) 2004 The Dialog Corp.
File  47:Gale Group Magazine DB(TM) 1959-2004/Apr 08
         (c) 2004 The Gale group
File  75:TGG Management Contents(R) 86-2004/Mar W4
         (c) 2004 The Gale Group
File  80:TGG Aerospace/Def.Mkts(R) 1986-2004/Apr 08
         (c) 2004 The Gale Group
File  88:Gale Group Business A.R.T.S. 1976-2004/Apr 07
         (c) 2004 The Gale Group
File  98:General Sci Abs/Full-Text 1984-2004/Apr
         (c) 2004 The HW Wilson Co.
File 112:UBM Industry News 1998-2004/Jan 27
         (c) 2004 United Business Media
File 141:Readers Guide 1983-2004/Apr
         (c) 2004 The HW Wilson Co
File 148:Gale Group Trade & Industry DB 1976-2004/Apr 08
         (c)2004 The Gale Group
File 160:Gale Group PROMT(R) 1972-1989
         (c) 1999 The Gale Group
File 275:Gale Group Computer DB(TM) 1983-2004/Apr 08
         (c) 2004 The Gale Group
File 264:DIALOG Defense Newsletters 1989-2004/Apr 07
         (c) 2004 The Dialog Corp.
File 484:Periodical Abs Plustext 1986-2004/Apr W1
         (c) 2004 ProQuest
File 553:Wilson Bus. Abs. FullText 1982-2004/Apr
         (c) 2004 The HW Wilson Co
File 570:Gale Group MARS(R) 1984-2004/Apr 08
         (c) 2004 The Gale Group
File 608:KR/T Bus.News. 1992-2004/Apr 08
         (c)2004 Knight Ridder/Tribune Bus News
File 620:EIU:Viewswire 2004/Apr 07
         (c) 2004 Economist Intelligence Unit
File 613:PR Newswire 1999-2004/Apr 08
         (c) 2004 PR Newswire Association Inc
File 621:Gale Group New Prod.Annou.(R) 1985-2004/Apr 08
         (c) 2004 The Gale Group
File 623:Business Week 1985-2004/Apr 07
         (c) 2004 The McGraw-Hill Companies Inc
File 624:McGraw-Hill Publications 1985-2004/Apr 07
         (c) 2004 McGraw-Hill Co. Inc
File 634:San Jose Mercury Jun 1985-2004/Apr 07
         (c) 2004 San Jose Mercury News
File 635:Business Dateline(R) 1985-2004/Apr 07
         (c) 2004 ProQuest Info&Learning
File 636:Gale Group Newsletter DB(TM) 1987-2004/Apr 08
         (c) 2004 The Gale Group
File 647:CMP  Computer Fulltext 1988-2004/Mar W4
         (c) 2004 CMP Media, LLC
File 696:DIALOG Telecom. Newsletters 1995-2004/Apr 07
         (c) 2004 The Dialog Corp.
File 674:Computer News Fulltext 1989-2004/Apr W1
         (c) 2004 IDG Communications
File 810:Business Wire 1986-1999/Feb 28
```

File 813:PR Newswire 1987-1999/Apr 30

Set	Items	Description
S1	46323	MAYA
S2	7166	S1 AND (ANIMATION OR SOFTWARE)
S3	151826	VERSION()(2 OR TWO OR SECOND)
S4	5830961	RELEASE
S5	187	S2 AND S3
S6	96	S5 AND S4
S7	69	S6 AND PY=2000:2004
S8	27	S6 NOT S7
S9	14	RD S8 (unique items)
S10	0	S1(3N)(SOFTWARE OR APPLICATION OR ANIMATION)(5N)RELEASE(3N-)DATE
S11	5674	1(3N)(SOFTWARE OR APPLICATION OR ANIMATION)(5N)VERSION()(2 OR TWO OR SECOND)
S12	2	S11(5N)RELEASE()(DAY OR DATE)
S13	2	RD S12 (unique items)
S14	1745	ALIAS()WAVEFRONT(S)S1
S15	729	S14(S)ANIMATION
S16	54	S15(10N)S4
S17	47	S16 AND PY=1999:2004
S18	7	S16 NOT S17
S19	5	RD S18 (unique items)
S20	5	S19 NOT S9

9/3,K/1 (Item 1 from file: 15)
DIALOG(R)File 15:ABI/Inform(R)

01820307 04-71298
Cult3D gives the Web new dimension
Fielden, Tim
InfoWorld v21n18 PP: 52-54 May 3, 1999
ISSN: 0199-6649 JRNL CODE: IFW
WORD COUNT: 782

ABSTRACT: Cycore Computers' Cult3D is reviewed. Cult3D is a highly optimized **software** solution that provides graphic artists and Web designers with a real-time, 3-D development...
...TEXT: realize the power of Cult3D 3.1.

Cult3D from Cycore Computers is a highly optimized **software** solution that provides graphic artists and Web designers with a real-time, 3-D development...

... enhancing Internet commerce, distance learning, and interactive Web sites.

Although Web-based 3-D and **animation** tools have been available for some time, many designers have steered clear because of their...

... com are two of the most noteworthy. However, Cult3D has an unusual pricing scheme: The **software** is free, but the company charges $3,600 per product line to display the images...

...Kinetix's 3D Studio Max. But Cycore has plans to enhance it in a future **release** to support other graphics products, such as Wavefront's **Maya** and Avid's Softimage. The **animation** tool, called the 3-D Designer, is a graphical stand-alone environment used to build and test **animation** segments. The suite is rounded out with a plug-in, or **animation** viewer, that enables end-users to view the images on the Web. It weighs in at just under 400K and works with Netscape browsers **Version** **2** .0 and later or Microsoft's Internet Explorer Version 4.0 or later.

(Illustration Omitted...

...save it, and display it on a Web page.

I purposely chose to test my **animation** using a 28.8Kbps modem, and what I experienced was not what I expected. Even...

DESCRIPTORS: **Software** reviews...

9/3,K/2 (Item 1 from file: 16)
DIALOG(R)File 16:Gale Group PROMT(R)

06550963 Supplier Number: 55396776 (USE FORMAT 7 FOR FULLTEXT)
Alias/Wavefront Revolutionizes Computer Animation **With** Maya **Paint Effects.**
PR Newswire, p8635
August 10, 1999
Language: English Record Type: Fulltext
Document Type: Newswire; Trade

Word Count: 1341

(USE FORMAT 7 FOR FULLTEXT)
Alias/Wavefront Revolutionizes Computer Animation **With** Maya **Paint Effects.**
TEXT:
Unprecedented New Paint Technology Changes the Nature of Computer **Animation**
... ANGELES, Aug. 10 /PRNewswire/ -- At SIGGRAPH today, Alias|Wavefront, an SGI (NYSE: SGI) company, announced **Maya** (R) Paint Effects, an unprecedented advancement in technology that enables any user to paint and...

...dimensional space. This revolutionary technology, available in the fall, will be a standard feature of **Maya** (R) 2.5 **software** in both **Maya** (R) Complete and **Maya** (R) Unlimited for Microsoft(R) Windows NT(R) and Silicon Graphics(R) IRIX(R) workstations...

...dropped open," said Nick Ericson, president of Nick Ericson Studios. "It is the most impressive **software** technology I have seen in a really long time. And, we're ready to use...

...deadlines."
Alias|Wavefront will showcase its groundbreaking Paint Effects technology and highlight additional features of **Maya** 2.5 at SIGGRAPH '99, Booth 1415. **Maya** Paint Effects and the announcement of **Maya** 2.5 reinforces Alias|Wavefront's position as the industry leader in developing innovative computer...

...accelerate the rate at which it delivers new and cutting-edge technology based on the **Maya** (R) architecture.
"When I saw the prototype demonstration of Paint Effects at last year's...

...Genius(TM)
Paint Effects is a powerful artist's tool for the instantaneous creation and **animation** of stunning organic and painterly effects -- redefining the way artists add beauty and complexity to 3D scenes.
"Not only is Paint Effects a terrific addition to the **Maya** tool set, it is a feature that is unmatched by any other **software** in the industry," says Loren Olson, technical director at Rhonda Graphics. "It moves beyond traditional...

...be amazed by its power. The fact that Paint Effects will be a feature in **Maya** 2.5 is truly amazing. Once again, Alias|Wavefront is revolutionizing the industry in ways we never dreamed possible!"
Completely integrated inside of **Maya** , Paint Effects comes with a myriad of editable pressure-sensitive preset brushes including:
Effects Brushes...

...independent, and can include 3D cast shadows, depth of field, fog effects and motion blur.
Maya 2.5 Addresses Industry Needs
Maya 2.5 will deliver notable feature improvements, including Paint Effects and targeted features for game developers, to both the **Maya** Complete and **Maya** Unlimited products. **Maya** 2.5 will also introduce a new member of the **Maya** product line, **Maya** (R) Builder. **Maya** Builder, which is also being announced at SIGGRAPH '99, is a subset of **Maya** Complete and will be a low-cost product for creating polygon based content that addresses...

...says Warren Pratt, president of Alias|Wavefront. "By including unequalled improvements like Paint Effects in **Maya** 2.5, we're providing a higher level of functionality that's completely integrated -- delivering the kind of features and enhancements our users have come to expect."

Additional **Maya** 2.5 Features Include:

* New Polygon Modeling Tools -- Includes Level of Detail (LOD) and polygon...

...TM) Processors -- Streaming
SIMD Extensions (SSE) includes enhancements to the critical code paths
of the **Maya** Renderer, resulting in rendering time improvements of up to
30 percent.

* ClipFX Libraries -- Additional ClipFX...

...with corresponding source
code provided for run-time deployment on game platforms.

Pricing and Availability

Maya Complete 2.5, **Maya** Unlimited 2.5 and **Maya** Builder 2.5 are scheduled to ship in the fall 1999. **Maya** Complete 2.5 has a SRP of $7,500 (US) and includes modeling, rendering, **animation** , dynamics, and **Maya** (R) Artisan. **Maya** (R) MEL, **Maya** **software** 's Embedded Scripting Language, and the full **Maya** API for programmers are available in all products. **Maya** Unlimited 2.5 has a SRP of $16,000 (US) and, in addition to the features of **Maya** Complete, includes **Maya** (R) Live, **Maya** (R) Fur, **Maya** (R) Cloth and the new Advanced Modeling features. All purchases of **Maya** Complete and **Maya** Unlimited after August 9, 1999 include a free upgrade to **version** **2** .5 upon its **release** . The new **Maya** Builder is expected to have a SRP of $2,995 (US). (Prices are indicated in...

...As the world's leading innovator of 2D and 3D graphics technology, Alias|Wavefront develops **software** for the film and video, games, interactive media, industrial design, and visualization markets. Alias|Wavefront...

...PDI), Pixar, Santa Barbara Studios, Sony Pictures Imageworks, The Walt Disney Company, and Warner Feature **Animation** . Games/Interactive customers include CAPCOM, Electronic Arts, Iguana Entertainment, Interplay, Kronos Digital Entertainment, NAMCO, Naughty...
...Square, Virtual Worlds Entertainment, and Williams/Bally Midway.

Alias|Wavefront is a wholly owned, independent **software** company of SGI with headquarters in Toronto and technical centers in Seattle and Santa Barbara...

...of Silicon Graphics Limited. Silicon Graphics and IRIX are registered trademarks of Silicon Graphics, Inc. **Maya** and the **Maya** logo are registered trademarks of Silicon Graphics, Inc. exclusively used by Alias|Wavefront, a division...

9/3,K/3 (Item 2 from file: 16)
DIALOG(R)File 16:Gale Group PROMT(R)

06286868 Supplier Number: 54442264 (USE FORMAT 7 FOR FULLTEXT)
DreamTeam Unleashes an Animation **Typhoon.(Typhoon 2.1** animation software **)(Product Announcement)**
Belleville, Laureen

Computer Graphics World, v22, n4, p9(1)
April, 1999
Language: English   Record Type: Fulltext
Article Type: Product Announcement
Document Type: Magazine/Journal; Trade
Word Count: 232

(USE FORMAT 7 FOR FULLTEXT)
DreamTeam Unleashes an Animation **Typhoon.(Typhoon 2.1** animation software **)(Product Announcement)**
TEXT:
...of Typhoon from DreamTeam aims to solve many of the problems that haunt real-time **animation** . With **version 2** .1, this **software** for Windows NT and SGI platforms can run single-skin characters in real-time, which allows realistic, fluid, bending of joints and the **animation** of characters wearing free-swinging clothing. Through integration with ArtiFace **software** from Techimage, Typhoon enhances the authenticity and precision of real-time facial expressions.

Version 2 .1 further increases real-time graphics capabilities by the addition of real-time video texture support. This **release** also enables the seamless insertion of single-skin characters into a virtual set. Complex single...

...support for a real-time optical motion-capture technology made by Motion Analysis. On the **software** side, complete support for Alias|Wavefront's **Maya** as well as Kinetix's 3D Studio Max 2.5 enables import and export of **animation** between Typhoon and these other programs.

Recorded data can be sent back to the original **software** for high-quality post-production applications. A new set of motion-editing tools enables users...

...accommodate these features, new plug-ins and scene control devices have been added to the **software** 's "Pipeline," which provides an intuitive method for scene manipulation.

Pricing depends on hardware platform...
PRODUCT NAMES: 7372449 (Graphics **Software** NEC)
NAICS CODES: 51121 (**Software** Publishers)
TRADE NAMES: DreamTeam Typhoon 2.1 (**Animation software**)

9/3,K/4 (Item 3 from file: 16)
DIALOG(R)File 16:Gale Group PROMT(R)

06105467 Supplier Number: 53682482 (USE FORMAT 7 FOR FULLTEXT)
1998 Innovation Award.(20 hardware and software **products, Computer Graphics World)(Evaluation)**
Computer Graphics World, v22, n1, p27(1)
Jan, 1999
Language: English   Record Type: Fulltext
Article Type: Evaluation
Document Type: Magazine/Journal; Trade
Word Count: 2692

1998 Innovation Award.(20 hardware and software **products, Computer Graphics World)(Evaluation)**
... new concepts, which can be stored along with the user's existing knowledge in the **software** 's knowledge base. Other modules propose solutions, analyze patents, and transfer features from one engineering...

...tripod-mounted scanner uses pulsed-laser technology and high-speed scanning optics. The system includes **software** for creating solid models from point-cloud data and porting the models directly into CAD...

...CA; 408-969-8000, www.vds.com) InfoNow number 54

VisFactory

A novel suite of **software** for designing, visualizing, and simulating factory layouts, VisFactory from Engineering **Animation**, Inc. (EAI) allows users to design and edit factory layouts without having to draw models...

...explore volumetric datasets (which by their nature are huge) using standard graphics applications. With the **software**, users can roam through datasets of up to 100GB and can take advantage of available...

...InfoNow number 58

Character Studio 2.0

The technology behind the dancing baby phenomenon, this **software** for 3D Studio Max provides a complete **animation** package for creating characters and their movement. It offers new skin deformation tools as well as breakthrough motion capture, editing, and blending technology combined with traditional keyframe **animation** and Character Studio's previous footstep-driven technique, so animators can create realistic-looking characters that walk, jump, and dance. In this **release**, the company has redesigned its Physique deformation system to provide intuitive control over deformation. Its Biped **animation** system now combines the speed of footstep-sequence editing, motion-capture import, and motion blending with traditional keyframe **animation** and inverse kinematics. To save time, animators can now reuse motion files by copying movement...

...networks can be created that establish complex relationships between particles and other aspects of an **animation** /effects pipeline. POPs can be used to create photorealistic natural phenomena, simulate crowd behavior, deform...

...cloth and create natural forces such as wind. Price: $17,000 for Houdini. (Side Effects **Software**, Inc., Toronto; 416 504-9876 www.sidefx.com) InfoNow number 60

Wildcat 3D Graphics Technology...

...800-763-0242, www.intergraph.com) InfoNow number 61

ArtiFace 1.5

TechImage's facial **animation** **software**, ArtiFace, maps human expressions and facial movements to any 3D model. Using a video film...

...The Motion Factory, Fremont, CA; 510-505-5151, www.motion-factory.com) InfoNow number 65

Maya

Alias|Wavefront combined some of the most innovative ideas in **software** design with graphics technology to create a blazingly fast 3D **animation** **software** program. With a node-based architecture, the **software** is inherently flexible; its MEL scripting language gives users the ability to customize and extend...

...its SDK allows programmers to seamlessly integrate additional functions. Price: IRIX and Windows NT, $7500.

Maya Artisan

This Advanced Module for **Maya** helps turn digital modelers into 3D artists and sculptors. Artisan, control vertices (CVs) on a NURBS model can be manipulated using a brush. Artists can join surfaces using the **software**

's edge manipulator. And, when an artist moves a brush over a surface, a grayscale...

...MEL scripts and brush the results onto a surface. Price: IRIX and Windows NT, $6000.

Maya Cloth

Rather than mimic the behavioral properties of fabric with a soft body spring mesh, **Maya** Cloth models the bending and shear forces of fabric based on ...capture suit for 3D animators, which allows users to perform character, facial, hand, and scene **animation** . Traditionally, such tasks require more than one motion-capture device, but Puppet Works offers a...

...into place and quickly attached to a CG character through the company's plug-in **software** . The suit is capable of recording up to 20 minutes of realtime performance captured at...

...captures surface details. As the wand sweeps contiguous swaths of laser light over an object, **software** stitches together the data to reconstruct the object's surface. The unit is intended for...

...including reengineering, reconstructive surgery, and character modeling. The system is compatible with many industry standard **software** packages. Price: $29,995. (Polhemus Inc., Colchester, VT; 802-655-3159, www.polhemus.com) InfoNow...

...capture is increasingly popular with filmmakers and others interested in low-cost alternatives to traditional **animation** , it can be daunting to work with. A tool that goes a long way toward taming this unruly technology is Kaydara's Filmbox, a motion-capture editor and performance **animation** engine. This highly interactive and relatively easy-to-use program allows the real-time editing...
...new polygon reduction tool helps designers of 3D games, VRML Web applications, and real-time **animation** render their work more speedily and accurately. With geomagic Decimator, designers can, in real time...

...the model, compress it, create splines, and translate the model to major 3D file formats. **Version 2** .1, which shipped this year, offers better handling of large data files, a **software** developer kit, and an improved user interface with multiple windows. Price: $3,495. (Raindrop Geomagic...
COMPANY NAMES: Invention Machine Corp.; Cyra Technologies Inc.; Visionary Design Systems Inc.; Engineering **Animation** Inc.; Fakespace Inc.; Caligari Corp.; Silicon Graphics Inc.; Kinetix (San Francisco, California); Side Effects **Software** Inc.; Intergraph Computer Systems; TechImage, Ltd.; Positron Corp.; Motion Factory; Alias\\Wavefront Inc.; Sven Technologies...
PRODUCT NAMES: 7372431 (CAD/CAM/CIM/CAE **Software**); 7372449 (Graphics **Software** NEC); 7372513 (Application Development **Software**); 3573293 (Computer Graphics, Sound and Video Processors); 3679582 (Liquid Crystal Displays); 3573253 (Virtual Reality Output...
NAICS CODES: 51121 (**Software** Publishers); 334119 (Other Computer Peripheral Equipment Manufacturing); 334419 (Other Electronic Component Manufacturing)
TRADE NAMES: TechOptimizer (CAD/CAM **software**); Cyrax 3D Laser Imaging Systems (CAD **software**); IronCAD (CAD **software**); VisFactory (CAD/CAM **software**); VersaBench (Graphics/imaging utility); trueSpace4 (CAD **software**); OpenGL Volumizer (Application development **software**); Character Studio 2.0 (**Animation** software); Houdini (CAD/CAM **software**); Intergraph Intense 3D Wildcat (Graphics accelerator/display board); ArtiFace 1.5 (**Animation** **software**); Silicon Graphics 1600SW (LCD

display); Positron TrU-V (Paint **software**); Motivate 1.5 (CAD **software**); **Maya** (**Animation** **software**); **Maya** Cloth (**Animation** **software**) ; **Maya** Artisan (**Animation** **software**); SurfaceSuite Pro 1.1 (Image processing **software**); Puppet Works Desktop Motion Capture System (Virtual reality device); Polhemus Handheld Laser Scanner (Virtual reality device); Filmbox 1.4 (**Animation** **software**); Decimator (**Animation** **software**); Wrap 2.1 (**Animation** **software**); Wrap (CAD **software**)

9/3,K/5 (Item 4 from file: 16)
DIALOG(R)File 16:Gale Group PROMT(R)

05839367 Supplier Number: 50351045 (USE FORMAT 7 FOR FULLTEXT)
MAYA **MANIFEST**
GIAMBRUNO, MARK
Interactivity, v4, n10, p51
Oct, 1998
Language: English Record Type: Fulltext
Article Type: Article
Document Type: Magazine/Journal; Trade
Word Count: 4534

MAYA **MANIFEST**
ALIAS WAVEFRONT **MAYA** 1.0 FOR IRIX & WINDOWS NT
Ma'ya: 1. The Hindu goddess Devi (or Shakti...

...the illusory world of the senses, often personified as a woman.
An illusion no more, **Maya** recently materialized on both SGI and NT platforms after months of user and press speculation...

...Wavefront's next-generation 3D package. Although expected to replace PowerAnimator (PA) at some point, **Maya** is still incomplete, so it is billed first and foremost as a character **animation** and special effects package with integrated modeling and compatibility with PA'S high-end tools. This character **animation** focus is Alias' response to its long-standing reputation of being first in modeling hut second in **animation** to Softimage.
Maya is not simply an upgrade in the Power-Animator mold. It represents a new design...

...been demonstrated by Kinetix 3D Studio MAX. With an NT version that shipped in June, **Maya** is positioned to compete more directly with PC champ MAX, as well as dual-platform...

...on high-end NT boxes, so it seems likely we'll see PC-based hardware/ **software** bundle deals just as we've seen with Irix systems and Alias in the past.
So, does **Maya** live up to the hopes and expectations that have been built up around it? To...

...out, I spent several days in numbingly cold but warmly hospitable Toronto receiving instruction in **Maya** from trainer Mark Conahan. Back home land equipped with a hot SGI Octane -- see "High...

...56), I spent additional time exploring the package to bring you this evaluation.
Installation & Interface
Maya comes in an imposing black slipcase with three silver

emblem-embossed pull-out drawers housing...

...Alias, Wavefront, and TDI while trying to inject more contemporary icon-based controls. In contrast, **Maya** 's interface has gone through a substantial streamlining and reworking. Favorite items like tool shelves...

...off in all views.

Several of PA's user interface shortcomings have been addressed in **Maya** . Numerical data entry now lets you navigate down to the desired parameter field using tab...

...represents everything in the scene as a series of connected nodes (Fig. 3). In addition, **Maya** features a Dependency Graph view that shows the upstream/downstream nodal connections between objects, and...nine square-bound manuals housed in a handsome black triple slipcase emblazoned with the silver **Maya** logo. Learning **Maya** contains the user tutorials, with figures in full color. The other books, such as Using **Maya** : Basics, Modeling, Rendering, Dynamics, are mostly in black and white. The indices seem adequate, but...

....style tool tips that pop up to tell you the function of a given button. **Maya** does this via the status line at the bottom of the screen, but it's ...

...you have to look back and forth when browsing through a group of controls.

Finally, **Maya** 1.0 doesn't offer multiprocessor support which is scheduled to be included in **version** **2** .0. It's possible to launch a second **Maya** application on the other processor and use it for rendering, however.

Modeling

Industrial strength NURBS modeling has always been Alias/Wavefront's key feature, and **Maya** inherits a good portion of this attribute from PA. Birail, an advanced modeling add-on to the older product, is included with **Maya** in addition to the built-in NURBS toolest. **Maya** doesn't currently have a fully advanced modeling component, so users purchasing that option will...

...be used to create slider-controlled blends between targets for easy, precise control of facial **animation** , and it can also be used on 2D splines.

A few grumbles: When scenes start to get complex, it's helpful to color-code objects. Like many 3D tools, **Maya** has this capability, but assigning a color to an object is surprisingly clumsy, and you...

...to mirror an object, you set the scale value to a negative number.

Finally, although **Maya** has many improvements over PowerAnimator, one thing that hasn't changed is that many construction...

...a good handle on cameras and lighting, and outside of universal shadow casting and manipulators, **Maya** offers no earth-shattering improvements.

As with PA, **Maya** 's cameras don't suffer from the rollover problem that occurs in some programs when...

...and so on is provided via 3D manipulators, which are employed for lights as well.

Maya has a typical complement of point, spot, and directional light sources, It lacks the linear...

...to predict and adjust the characteristics of the light with fewer test renders, In addition, **Maya** lets you adjust and reposition lights in a

shaded view and observe how the changes...

...it eliminates a lot of test rendering, at least during the rough adjustments. Oddly, although **Maya** has default lighting for modeling, it doesn't kick in when rendering a scene, so...

...to add lights at that point.

PowerAnimator's Digital OptiFX tools have migrated over to **Maya** , enahling you to create lens flares, glows, and visible light effects such as fire and...through menu commands. The shading group tool, however, does provide point-and-click material assignment.

Animation

When it comes to **animation** , **Maya** shines. Its user-friendly but powerful timeline controls have a lot to do with it. On top of that, a lot of effort has gone into creating powerful character **animation** functions, from robust 1K to the **Maya** Embedded Language (MEL) scripting language. MEL scripts can be used to define sophisticated mathematical interrelationships between objects or to control **animation** with simulationlevel accuracy MEL scripts can also be used to create custom Ut controls for...

...with the OpenMaya C++ API. Plug-ins can reference or be referenced by MEL scripts.

Maya 's timeline makes it quick and easy to select a particular frame or range to manipulate. You can shift, copy, cut, and paste keys or segments of **animation** directly. In addition, when working on soundsynced projects, a waveform can be loaded and displayed directly in the timeline. Naturally, **animation** can be viewed and manipulated in other ways as well, such as via interactive motion graphs or the dope sheet (an alternate timeline view that lets you see the **animation** as a whole, which is useful for viewing multiple objects). For numerical entry or fine tweaks, the Channel box provides specific numerical data about each attribute and its **animation** .

The SET DRIVEN KEY function lets you create expressions in function curves and limits without...

...a color change in the skin creases.

Inverse kinematics is a key component of character **animation** , and **Maya** offers three built-in solver types: single chain (standard 1K), rotate plane (which prevents flip-over), and 1K spline (for **animation** of the chain using a spline). A multichain solver (especially useful for manipulating motion capture...

...joints (Fig. 7). For additional help in selecting and controlling complex characters and 1K chains, **Maya** offers selection handles and jacks that can be placed away from the mesh hut move...

...it.

In addition to a high-res mesh that you might attach to a skeleton, **Maya** lets you connect a low-res proxy model as well. This lets you work with...

...toggle the visibility of the two models and make hi-res test render of the **animation** .

Flexors are lattice-type deformers that form a cage around a section of mesh such...

...and knees.

Rigid body dynamics have become very popular in full-featured 3D packages like **Maya** . Dynamics solvers enable the user to employ real-world forces such as gravity, wind, mass...

...to animate by hand, but by setting the proper attributes to the ball and pins, **Maya** handles the rest automatically. To reduce unnecessary computation time, you can set the stand-in...

...can perform a "bake simulation" that converts the solver data into keyframes, so that the **animation** is still presented, but without recalculating the physics every time. Although you can't keyframe...
...then adjust it manually.

Soft body dynamics is usually a separate add-on feature, and **Maya** is no exception - you have to buy the optional **Maya** F/X ($6,000) for this. Like rigid body dynamics, it uses real-world forces to create **animation** , but in this case, the object itself is deformed by the characteristics and forces that...

...to. An excellent application for soft body dynamics is simulating the movement of cloth, and **Maya** 's implementation lets you adjust the goal weight of every particle, as well as apply springs to simulate elasticity.

In addition to soft body dynamics, you' ll need the **Maya** FIX module to get the kinds of particle system effects that are almost a must in today's **animation** world. **Maya** is unusual in that you can plunk down and control individual particles with MEL scripts...

...in hardware for greater speed, but you'll need to composite the particles with the **software** -rendered portions of the image using a compositing package, such as Alias/Wavefront Composer. Other particle types (such as those used for blobs, clouds, smoke, and fire) are rendered in **software** along with the geometry. Surprisingly, **Maya** FIX doesn't offer a built-in way to use custom particle geometry - a method...
...be accomplished via MEL scripting or expressions.

Although they're not part of the basic **Maya** package, a couple of add-ons are worth mentioning. **Maya** Artisan ($6,000) is a unique modeling tool that makes use of a pressure-sensitive...

...paint geometry onto a landscape, and interactively adjust goal weights for refining character skin deformation. **Maya** Live ($6,000) is a camera-tracking utility for accurately combining 3D imagery and filmed...

...to the way CG dinosaurs were added to hand-held footage in Jurassic Park.

Conclusions

Maya is a strong step in the right direction for Alias/Wavefront, not only because it has revised the GUI and pumped up the character **animation** capabilities, hut also because the program has dual-platform operability This will enable Alias/Wavefront...

...hold on to its high-end modeling crown while making inroads against Softimage for character **animation** , and also attract users of other NT-based **software** who don't want to switch hardware.

Of course, with the PC power curve surging...
...end features into lower-priced 3D products, price/performance remains a major consideration. After all, **Maya** and its add-ons can add up to the cost of two or more NT seats complete with competing **software** .

All in all, **Maya** seems very hearty for a 1.0 **release** . With the introduction of **Maya** NT, one of my main reservations about Alias/ Wavefront **software** - hardware requirements - has evaporated. Still, the price must be weighed against perceived productivity gains. If **Maya** and **Maya** FIX could he purchased for $8,000 total, I would have no complaints. Cost aside...

...addition to the computer animator's toolbox.

Thanks to Alias/ Wavefront for providing training and **Maya** **software** and to SGI for the loan of an Octane workstation. Also, thanks to Mondo Media...

...as workstation guru.

PROS & CONS

Rating

*****

Pros

Powerful 3D modeling coupled with very strong character **animation** capabilities. Excellent shaders, lighting, camera features, and rendering. MEL scripting language extends program capabilities and interface.

Cons

Expensive, particularly with options like **Maya** F/X (almost a requirement for full-featured **animation**). Poorly organized menus and dialog boxes. Doesn't take advantage of multiple processors.

Bottom Line

A strong move for Alias / Wavefront, strengthening their position in both character **animation** and multiplatform support. **Maya** feels less esoteric to me than the older products, and because of that, I'm more comfortable with it. My only major reservation is the price tag.

ALIAS/WAVEFRONT **MAYA** 1.0 FOR IRIX

Description

3D modeling, **animation** , and rendering for Irix and NT aimed primarily at character **animation** .

System Requirements

Irix 6.2 or higher. SGI computer (or IBM RS/6000) with R4000...

...other deforms can be used for modeling characters and freeform shapes. Procedural modeling with MEL **Animation** : path **animation** , set driven key, graph editor, dope sheet, channel box, and expressions. Constraints: point, aim, orient...
...effects. Real-world camera lens: depth of field, f/stop, focal length, and film format. **Maya** F/X (optional module): hardware and **software** particle rendering. Soft body dynamics. Extensible integrated particle system with expression-based and keyframe control...

...MEL, DXF, OBJ, IGES, MOV. 2D: GIF, Softimage, Wavefront RLA, TIFF, SGI RGB, Alias PIX, **Maya** IFF, JPEG, EPS, Cineon, Quantel.

Suggested Retail Price

$7,500 **Maya** , $6,000 **Maya** Artisan, $6,000 **Maya** FIX, $6,000 **Maya** PowerModeler, and $6,000 **Maya** Live.

Contact

Alias/Wavefront, 210 King St. East, Toronto, Ontario, Canada M5A 1J7; vox 800 do the **Maya** review, I pointed out that I was a Windows 95/NT user, and would need...

...result In the superior performance that SGI systems are noted for.

Unfortunately, my main application, **Maya** 1.0, doesn't yet support multiple processors, so] wasn't able to take full advantage of the power of the system. However other tasks I ran concurrently with **Maya** shifted between the processors automatically and resulted in no apparent slowdown in the 3D package...
...MXE graphics hardware in this system did handle shaded views of 3D objects handily, making **Maya** 's interactive lighting and **animation** features fast and enjoyable to use. Several of my coworkers and I prowled through the...
PRODUCT NAMES: 7372000 (Computer **Software**)
NAICS CODES: 51121 (**Software** Publishers)

9/3,K/6 (Item 5 from file: 16)
DIALOG(R)File 16:Gale Group PROMT(R)

05429645 Supplier Number: 48234486 (USE FORMAT 7 FOR FULLTEXT)
Design Software
Electronic News (1991), p028
Jan 19, 1998
Language: English Record Type: Fulltext
Document Type: Magazine/Journal; Trade
Word Count: 1099

(USE FORMAT 7 FOR FULLTEXT)
Design Software
TEXT:
...multi-national transactional capabilities, ERP integration and database support with Aspect's Explore decision support **software** and VIP data content. Available now to joint customers is the ability to call up...
... users. Participating CAD vendors include: Bentley Systems, Cadence Design Systems, CoCreate, Incases, LTX (EDS/Unigraphics), **Maya** Heat Transfer, Mentor Graphics, OrCAD, Parametric Technology Corp., SDRC, VeriBest and Zuken-Redac. Harris, Hewlett...

...VeriSure, a product recently selected by Cadence Design Systems to integrate with their logic simulation **software** , NC-Verilog. This latest **release** of VeriSure offers new code coverage technology which is said to deliver a 2x increase...

...FPGA Express, FPGA Compiler and Design Compiler products. Architecture-specific synthesis algorithms within FPGA Express **version** 2 .0 allow designers to use Spartan devices with on-chip SelectRAM memory. Optimized Spartan synthesis...

...FPGA Express will also be available to Xilinx customers in the Foundation v1.4 design **software** package. The relationship promises timely device support and tangible quality of results improvements. Using FPGA...

...driven methodology to achieve the best performance in their chosen Spartan device. Also, FPGA Express **version** 2 .0 now includes advanced area optimization algorithms based on technology from Design Compiler product, for...

...time. i-Logix, Motorola and Daimler-Benz are working together to improve embedded systems design **software** for designers utilizing the OSEK standard. The specific goal of the development project is to...

...is OSEK-compatible and targeted to Motorola's microcontrollers from i-Logix's Statemate Magnum **software** . No timetable has been established for the joint development.
C-Solutions will implement Spatial Technology's ACIS 3.0 into its 3-D Geometric Modeling Software (GMS) Smart Modeler, a solid modeling product that is integrated with a full range of...

...not disclosed.
Accel Technologies of San Diego released a Web-based product data management (PDM) **software** system, Accel PDM. It is the first venture into this
PRODUCT NAMES: 7372416 (Manufacturing, Distribution & Retailing

Software); 7372431 (CAD/CAM/CIM/CAE **Software**); 3674191 (Data Communications ICs); 3674110 (Integrated Circuits)
NAICS CODES: 51121 (**Software** Publishers); 334413 (Semiconductor and Related Device Manufacturing)

9/3,K/7 (Item 1 from file: 148)
DIALOG(R)File 148:Gale Group Trade & Industry DB

10320158 SUPPLIER NUMBER: 20559139 (USE FORMAT 7 OR 9 FOR FULL TEXT)
Right on track. (five camera tracking software **products that enable producing live-action scenes from 3D graphics) (Product Information)**
Robertson, Barbara
Computer Graphics World, v21, n5, p48(3)
May, 1998
ISSN: 0271-4159 LANGUAGE: English RECORD TYPE: Fulltext; Abstract
WORD COUNT: 1372 LINE COUNT: 00108

Right on track. (five camera tracking software **products that enable producing live-action scenes from 3D graphics) (Product Information)**

ABSTRACT: 3-D camera-tracking **software** enables animators derive data to match live action scenes with 3D model shots. To use Kinetix's Camera Tracker feature in its Max 2.5 **software** , the user identifies six well-defined trackable features in the movie footage. The position measurements...

...of identifiable features in screen shots. The company also uses creative techniques to use the **software** when there is a lot of motion blur in the scenes. For example, for the...
...controlled strobes in cameras which measured the location of LEDs placed in the scene. The **software** automatically tracked the location of the bright objects.

TEXT:
Camera tracking **software** that helps plug 3D graphics into live-action scenes is becoming available, but there's...
... the streets of San Diego, you share the same basic problem: You must fit an **animation** of a 3D model within 2D live-action footage so that it looks like they...

...the lens zooms in and out
The first two companies to offer 3D camera-tracking **software** that helps animators and match-movers derive the needed data from live-action shots were...

...track **software** about two years ago, according to Thad Beier, director of technology. "We've sold a...

...licenses now, mostly via word of mouth," he says. Science-D-Vision has just completed **release** 6, **version** **2** of its 3D Equalizer (3DE) **software** , which is used by many large visual-effects studios, according to Rolf Schneider, a researcher...

...Wavefront's new **Maya** Live is a **Maya** -only module available for SGI, and Kinetix's new 3D camera-tracking feature works only within its NT-based Max 2.5 **software** .
How They Run
* To use the Camera Tracker feature in Max 2.5, you would...

...with the previously identified features in the movie. Using this information, the program computes the **animation** path for a virtual camera to match the live-action scene. The tracking is an...at $1,500, provides camera data as text files and as Alias SDL files.

* With **Maya** Live, an animator starts by pointing and clicking on reference points in a live-action...

...designate features such as a rock or a depression on the ground, according to Jacobs. " **Maya** Live automatically tracks those reference points in 2D and then calculates the third dimension," he...

...the process, if a rock is selected as a feature in the live-action plate, **Maya** Live draws a box around it then analyzes the position of the 2D box in...

...of the camera used to shoot the scene and the rock

"The result is a **Maya** camera that's a duplicate of the real camera, and it's animated over time," says Jacobs. Because **Maya** Live is integrated within **Maya** , the reference points can be used to build geometry and to position geometry, according to Jacobs. Alias I Wavefront expects to begin shipping the $10,000 module in June.

* With **release** 6, **version** 2 , of 3DE, Science-D-Vision has added features to speed the tracking process, make it...

...provide a 3D representation of the set) to Softimage 3D, Power Animator, Explore Houdini Prisms **Maya** Max and Discreet Logic programs.

* SynaPix, founded by Curt Rawley and John Robotham, formerly CEO...

...Avid respectively, has been giving sneak previews of SynaFlex, a unique technology for merging 3D **animation** with video footage (film resolution is planned for later). "We process the video to extract...

...original textures. People will get the camera motion, then place proxies of 3D objects from **animation** **software** within the mesh and interactively choreograph the objects in space and time." Robotham says SynaFlex...

...DESCRIPTORS: Computer **software** industry...
PRODUCT/INDUSTRY NAMES: 7372452 (Desktop Video **Software**)
TRADE NAMES: Kinetix Max 2.5 (Desktop video **software**)--...

...track (Desktop video **software**)--

9/3,K/8 (Item 2 from file: 148)
DIALOG(R)File 148:Gale Group Trade & Industry DB

10238696 SUPPLIER NUMBER: 20632577 (USE FORMAT 7 OR 9 FOR FULL TEXT)
NAB draws record 105,000 as attendees explore TV's future. (National Association of Broadcasters convention)
Giardina, Carolyn; Goldrich, Robert
SHOOT, v39, n16, p1(6)
April 17, 1998
ISSN: 1074-5297 LANGUAGE: English RECORD TYPE: Fulltext; Abstract
WORD COUNT: 4229 LINE COUNT: 00331

...ABSTRACT: 1998. The event showcased various products for digital television broadcasting such as SynaPix's SynaFlex **software** for Octane and Discreet Logic's Edit nonlinear system. Other technologies launched in Las Vegas include Softimage's DS 2.0 **software** , Intergraph Computer

Systems' Intel/Windows NT-based computer hardware line and Scitex Digital Video's...

... Rawley has grabbed the golden ring a second time.

SynaPix demonstrated the development of SynaFlex **software** for Octane, due out at the end of the year, that could have an extensive... headquartered Softimage was at NAB demoing a beta version of DS 2.0 scheduled for **release** next month. A new keyer and enhanced color correction tools are among the latest features...

...based hardware product line with new models at varying price points.

Scitex Digital Video announced version 2 .0 of its Sphere nonlinear editing product line with 480 I support. "There will be...

...of graphics and effects creation."

"Puffin Designs has set the new standard for real-time **software** on the Mac platform, which makes Commotion the perfect complement for the Sphere workstations real...Java Developers' Program. London-based 5D developed a set of effects including particle and type **animation** systems, lighting effects and 5D's TV and movie simulation effects.

Additionally, Command Post/Toybox...

...at work on a video titling production containing modules for 2-D and 3-D **animation** and playback.

Telecine

The HD film scanner wars heated up with Cintel Inc., an Image...

...digitized still pictures on the set or on location and to alter those images via **software** that emulates the characteristics of motion picture film options (i.e. - speed, color balance, tone...generator graphics system from Broomfield, Colo.-based Evolving Video Technologies. Dubbed AnteroHD, it is a **software** product that runs on SGI's Onyx2 platform. It supports ATSC standards including 10801 and...

...HD uncompressed storage for roughly $100,000.

3-D

On the heels of its February **release** of **Maya** , Toronto-headquartered Alias/Wavefront, a wholly owned subsidiary of SGI, quickly introduced at NAB **Maya** for Intel architecture-based hardware running Windows NT. The NT-based **software** have the same $10,000 base price as the already released SGI version. It is scheduled to ship in June.

The F/X and Artisan modules for **Maya** will also be available on NT.

Meanwhile, Softimage showed version 3.8 of Softimage...

...3D with new character **animation** features, texturing and rendering capabilities and an "improved" user interface.

Among the new features are an **animation** sequencer, allowing users to work with groups of **animation** that can be managed independently; and an enhanced character skinning tool, allowing the user to...

...Seattle, Portland and Vancouver B.C.

Avid introduced Marquee, a resolution-independent 3-D title **animation** **software** with an Avid-style timeline. It is available for SGI and NT-based workstations and...

...in July, starting at $7,495.

Avid also launched Masquerade, a paint and 2-D **animation** system for Windows NT. The company said it builds on Avid's Matador paint system...

...under $10,000.

Integrated Computing Engines (ICE), the Waltham, Mass.-based maker of

hardware and **software** for fast visual computing, unveiled the next generation of ICE products for faster 2D and...

...the computing power of previous ICE systems. The hardware card boots ICE 2D and 3D **software** products for animators and special effects creators.

Enhanced ICE 2D products - including ICEfx for Adobe...products, based on an accelerated or ICE'd version of Maxon's Cinema 4D XL **software** , is scheduled for delivery in fall of 1998.

ICE also announced partnerships with Maxon Gmbh, Puffin Designs and Artel **Software** that extend Ice's technology to a variety of application areas such as 3-D **animation** and modeling, paint and rotoscoping, and TV-style DVE effects. ICE also plans to team...

...into Filmbox's audio track. It is expected to be available next month.

Side Effects **Software** in Toronto debuted its Houdini flexible procedural **animation** system 2.5 for use on Windows NT at the Intergraph Computer Systems booth. Houdini 2.5 delivers new high-end 3D **animation** capabilities on Windows NT.

Additional reporting by Robert Goldrich

...DESCRIPTORS: Computer **software** industry...

9/3,K/9 (Item 1 from file: 275)

DIALOG(R)File 275:Gale Group Computer DB(TM)

01792732 SUPPLIER NUMBER: 16944939 (USE FORMAT 7 OR 9 FOR FULL TEXT)

Multimedia source guide.(Supplement to T.H.E. Journal)(Buyers Guide)

T H E Journal (Technological Horizons In Education), v22, n10, pS1(64)
May, 1995
DOCUMENT TYPE: Buyers Guide ISSN: 0192-592X LANGUAGE: ENGLISH
RECORD TYPE: FULLTEXT; ABSTRACT
WORD COUNT: 37519 LINE COUNT: 03053

...ABSTRACT: a 32-bit digital video engine into the operating system. A comprehensive listing of multimedia **software** and hardware is included, as well as a vendor index.

Software

Multimedia Tools **Animation** Programs * Authoring **Software** * Graphics * Image-Editing Packages * Media Organizer Programs * Music-Editing **Software** * Presentation Programs * Video-Editing **Software** * Other **Software** Tools

Instructional **Software** Art * Business * Career Guidance * Computer Training * Foreign Language * ESL * Health Awareness Programs * Interdisciplinary * Language Arts * Mathematics * Music * Nature * Reference Science * Social Science * Special Education * Training * Other Instructional **Software**

Hardware

Computers Desktop Systems * Servers * CD-R Systems * Video-Editing Systems * Audio-Editing Systems Notebooks...

...diskette and now on CD-ROM, are booming and perhaps the fastest growing category of **software** in terms of home PC purchasers. Multimedia encyclopedias, for youngsters and adults, are bestsellers as...

...costs of multimedia computing downward. And as the installed base grows, so does interest in **software** development. Simultaneously, new authoring tools are enlarging the pool of potential developers, even down to... images; M-JPEG (motion JPEG) does video but no audio. Onboard hardware

compression is preterred; **software** compression is another option. Standards not mentioned above include DVI, Indeo, IBM RTV, MS Video...

...well, leaving a zero footprint behind. (Uninstall, by the way, will be mandatory for any **software** that aspires to the label "Windows 95 compatible." Auto Play is one more nod to...

...plans to learn, teach, work, play, govern, serve, buy or sell in the information society."

Software

Boomtown U.S.A.--that's the headline for multimedia **software** . Every day brings the **release** of more titles, both instructional programs as well as tools for graphics, authoring and presentations...

...on developers to meet those standards.

User expectation is actually a very powerful force in **software** development. Microsoft, for example, expects the debut of Windows 95 to set new criteria for faceted, the range of available **software** tools is similarly divided. At best, one can lump them into broad categories like authoring...

...as many packages have functions that cross categories.

We focus, in this directory, on the **software** of most use to educators and students. In terms of graphics, 2D and 3D **animation** packages are included; a different category holds other graphics applications, including image-editing programs.

Authoring...

...and can be utilized by users at many proficiency levels. In both cases, however, authoring **software** creates programs with which users interact, not just view.

For the latter, one would turn...

...old stand-bys like Harvard Graphics now boast new powers to include sound, video and **animation** as well.

Finally, we include media organizer packages, handy programs that enable one to collect...

...two categories as well.

Instructional Titles

In this section we list all types of instructional **software** that incorporates multimedia--whether it is on CD-ROM, diskette, videodisc or offered online.

Some...

...for student activities, reference and background information, and more. In addition to higher expectations for **software** quality, teachers have come to expect solid support materials as well.

Animation Software

Adobe Systems, Inc. Adobe Dimensions, 3D M

Alias Research, Inc. Upfront, 3D modeling, rendering & **animation** MW

AT&T Multimedia Solutions RIO Animator DW

Autodesk, Inc. Animator Pro D 3D Studio, **Release** 3 D Multimedia Explorer D

Crystal Graphics, Inc. Crystal 3D Designer D Crystal 3D Desktop Animator D

Gold Disk, Inc. **Animation** Works Interactive 2.0, authoring W **Animation** Works MW

Looking Glass **Software** Cheetah 3D, full-featured 3D graphics, **animation** & rendering tool W o

Macromedia Swivel 3D Professional, modeling, rendering & **animation** M

MacroModel 1.5, intuitively create 3D models from 2D reference objects MW Life Forms...

...Other CD titles
Virtus Corp. WalkThrough Pro 2.0, 3D modeling, rendering & navigation MW
Visual **Software** , Inc. Simply 3D, full set of 3D graphics tools plus tutorials for rendering, animations, etc...

...suite of 3 programs & 2 CDs of clip art & textures W SGI WinNT AXP
Authoring **Software**
Adventures for Gifted & Talented Click D Mouse - HyperCard Construction Set M
AimTech Corp. IconAuthor MWU...

...delivery OWU
Goal Systems International, Inc. PHOENIX Authoring System
(Goedecke, formerly) Spirit of Saint Louis **Software** Co. Authorsoft, to create electronic multimedia books more DW
Gold Disk, Inc. **Animation** Works Interactive 2.0 W
Horizons Technology, Inc. Open! Info Manager 2.0 W o...

...Inc. MediaDeveloper W MultiMedia Works for Windows MultiMedia Works Developer's Toolkit W
Looking Glass **Software** Mediaverse, cross- ...PC or Sun
Passport Designs, Inc. Passport Producer M Passport Producer Pro M
Paul Mace **Software** Visual GRASP GRASP 4.01 Multimedia GRASP
Performance **Software** , Inc. ACTIII Multimedia Authoring System, pkg for royalty-free creation of stand-alone apps D...

...System, create exercises with text, audio & video in English & 7 foreign languages MW
Pierian Spring **Software** The Digital Chisel, creates projects without scripting (grades 3-12+) M The Discovery Toolkit, monthly...

...Prentice Hall Multimedia Group Authorware Academic
Quality Computers, Inc. How To Multimedia M
Q*Media **Software** Corp. Q*Media for Windows 2.0, powerful, entry-level tool works seamlessly with other apps W
Ridgewood **Software** Ridgewood Authoring 2.0
Roger Wagner Publishing, Inc. HyperStudio, multimedia writing tool for teachers & students...

...Bridge titles CD Motion, MPEG-1 video CD Media, interactive cross-platform development & CD-R
Software Mart, Inc. CD-ROM Developer's Lab MW
Sparrowhawk Solutions, Ltd. Troubadour D
Spinnaker **Software** Corp. Spinnaker Plus 2.51 WM
StrayLight Corp. PhotoVR, photorealistic vidual reality engine D & DVI ...

...any audio CD or CD-ROM M
Total MultiMedia TMM Producer
Videodiscovery, Inc. Mediamax, authoring **software** for Level Ill videodisc interaction WM
Vision Imaging Media Master
Vision River Prostar Multicat, creates...

...auto*des*sys form*Z, 3D modeling & design M
Autodesk, Inc. AutoCAD LT W AutoSketch, **Release** 2 W

AXA Corp. Pencil Test, w/ sound, ink & paint, multi-plane camera effects; broadcast...

...Multimedia Workshop M
Digital Equipment Corp. Decimage Editor
Eastman Kodak Co. Renaissance, design/layout
Fauve **Software** Fauve Matisse, "real media" paint/imaging sw W Fauve xRES, for 20MB-LGB files MW
Fractal Design Corp. Painter **Version** **2** .0, "real media" painting MW Painter X2, add-on for Painter Sketch, pencil sketching MW ColorStudio, high-end image editing
Gold Disk, Inc. Professional Draw W Add IMPACT! W Gryphon **Software** Corp. Morph 2.5, for morphing & special effects (grades 8+) MW Gryphon Dynamic Effects, filters...

...grades 12+) M Gryphon Batch It!, batch processor for graphics files (grades 12+) M
HSC **Software** Kai's Power Tools, Photoshop plug-ins MW SGI HSC Digital Morph W KPT Bryce...

...manipulation via unique interface WM Kai's Suite Imaging: includes Tools, Morph Interactive WM
ImageWare **Software** , Inc. ImageWizard W MorphWizard, morphing W
Looking Glass **Software** , Inc. Cheetah 3D, modeler/renderer W
Lotus Development Corp. Freelance Graphics for Windows
Macromedia Free images inside C, C++, Visual Basic or MCI apps W
Music-Editing **Software**
AB-CD ROM Inc Music-editing CD-ROMs
Animotion Development Corp. MCS CD Master W MCS Sound Savers MOS SoundRevue MCS Sound Trak MCS Stereo
Ars Nova **Software** Songworks, songwriter's composition tools produces melody, chords & lyrics (grades 9+) M Asystem Sound Impression for Windows
Avid Technology, Inc. AudioVision **Release** 2.5, multi-track digital audio workstation
Be Bop Systems LimeLight, graphical MIDI sequencer D...

...enables musicians to compose, record, edit & print music W
Opcode Systems, Inc. Vision, professional sequencing **software** MO Studio Vision Pro, pro-level integrated MIDI digital audio recording sw M Sludio Vision...

...Roland Corp Roland Audio Toolworks W
Tandberg Educational, Inc. GapCart, ChoiceCart, VoiceCart, LexCart audio editing **software** Tudle Beach Systems WAVE For Windows, WAV editing **software** with digital effects works w/ any sound card Turtle Tools D Wave 2.0, wavetable...

...for Windows 2.0, MIDI Sequencer
Xing Technology Xingsound, real-time MPEG-1 audio compression **software**
Presentation Programs
Adobe Systems, Inc. Adobe Persuasion 3.0 MW
AimTech Corp. CATS MEOW U...

...The Multimedia Workshop, for students (grades 5+) MW o
Gold Disk, Inc. Astound! MW
HSC **Software** HSC InterActive W
Meyer **Software** On The Air, animated presentations M On The Road, playback-only M
Microsoft Corp. PowerPoint...

...presentations (grades 10-12) W o | download
WordPerfect Corp. WordPerfect Presentations 2.0
Video-Editing **Software**
Abbate Video, Inc. VideoToolkit 2.0, videotape cataloging, editing Quicktime moviemaking M VTK Plug In...
...Disk, Inc. Video Director W Amiga
Heifner Communications, Inc, PEGGER, automated JPEG compression Amiga
HSC **Software** LivePicture MW
IEV International, Inc. Revolution 1.0
in:sync Corp. Razor Professional, non-linear digital editing **software** edit & composite D2-quality (film) images on a computer W
Lenel Systems International, Inc. MediaRecorder...

...Technology Xingcd, full-screen MPEG-1 compression sw, trom TGA, AVI or BMP formats
Other **Software** Tools
AC&E, Ltd. VC Wizard, videoconferencing scheduling & control sw
Aris Multimedia Entertainment MPC Wizard...

...Digital Research CDR Publisher, desktop CD-ROM pre-mastering sw WMU
Digital Equipment Corp. DECtalk **Software** for OSF/1 & NT DECvoice for OpenVMS
Eastman Kodak Co. Photo CD Acquire Module for...

...Photoshop 2.0
Elektroson USA GEAR 2.5 Plus for Macintosh, CD-R pre-mastering **software** GEAR 3.2 for Silicon Graphics (SGI) systems GEAR 3.2 for Windows
Empress **Software** , Inc. Empress, a 4GL multimedia database OU
Lenel Systems Int'l, Inc. Lenel MCI Multimedia Drivers Kit for Windows, tor videodisc players, VCRS & cameras W Looking Glass **Software** ViperWrite, hypertext word processing pkg W o Lotus Development Corp. Approach, mm database W
Microsoft...users on an existing network
Vividus Corp. Cinemation M
Instructional Titles
Art
ABC/EA Home **Software** EA Art Center M Video Jam
Artbeats Marble & Granite, texture maps MD o Other Cds of texture maps for 3D models **animation**
AXA Corp. Pencil Test, w/ sound, ink & paint, multi-plane camera effects; broadcast quality
Aztech...

...Videodiscs, videotapes & films
Fractal Design Corp. Dabbler, learn-to-draw MW o
Fife and Drum **Software** Revolutionary War. Gallery of images o Powers of Persuasion o Archival public domain historical images
Form and Function Wraptures, texture maps M o
Gryphon **Software** Corp. Colorforms R| Computer Fun Set series, combines graphics objects, sounds & words (pre-K-4...

...Business Job - Power Source, covers resumes, letters interviewing skills (grades 12+) DW o
InterMedia Interactive **Software** , Inc. Lovejoy's College Counselor o
Macmillan/McGraw Hill BEACON - College & Career Planning W o...

...decisions
Computer Training
Cedrus, Inc. Windows Basics *

ComputerPREP CD-PREP Interactive, various titles for learning **software** applications o
Course Technology Interactive Microsoft Windows 95, a course to master basics of Win95 (grades 12+) o
Glencoe Publishing, Inc. Understanding Computers Through Applications D videodisc/sw pkg
Individual **Software** , Inc. Multimedia Typing Instructor, teaches touch typing via travel theme (grades ...Spanish *
HRB Systems Cine Interactive, foreign movies for language training (grades 9+) DM o*
HyperGlot **Software** Co. Learn to Speak Series W o LinguaROM II M o Other CD-ROMs for...
...International Communication Studies Authentic foreign language videodiscs in French, German & Spanish with PICS Listening Tool **Software** D Dasher, foreign language authoring system MW
ScoftForesman Encuentres A lo Vivi * Pris Sur le...

...Systems ESL-2000, a 600-hour course to teach English (grades 9+) DW *o
HyperGlot **Software** Co. English as a Second Language Series o
Intechnica International, Inc. I Speak English Beginner...

...CPR/Advanced Cardiac, Life Support self-study courseware * Other healthcare videodiscs
A.D.A.M. **Software** , Inc. A.D.A.M. Comprehensive, anatomical study presentation (graduate or professional) MW o
AMT **Software** (Advanced Multimedia Training) Interactive Guide to Fusion Devices, CBT series to train medical/nursing students...

...Care: ABC's of Nursing * Basic Nursing Skills series *
Personal Health
A.D.A.M. **Software** , Inc. A.D.A.M. Essentials, fundamentals of human anatomy & the body's functions (K...Zeeno- Prepared & Survivor, teaches preparedness & survival skills (grades 1-5) o |
Interdisciplinary
ABC/EA Home **Software** Ping & Kooky's Cuckoo Zoo, early learning MD Scooter's Magic Castle, early learning MD...

...MW
Image Smith, Inc. Yearn-2-Learn MDW Yearn-2-Learn Snoopy MW
InterMedia Interactive **Software** , Inc. Reader's Digest Multimedia Crosswords, with video picture clues from history, literature, etc. o...

...pre-K-4) MW o
StarPress Multimedia Why Do We Have To?, early learners
SOLEIL **Software** , Inc. Zurk's Learning Satari, math, reading & science concepts in a discovery environment (grades pre...

...Writing, Spelling Interactive o V. A. K. T. Multisensory Gillingham instruction o
ABC/EA Home **Software** Rudyard Kipling's The Jungle Book, 3rd in Creative Reader series (grades K-3) MW...

...titles, w/ HyperStax interface for Macs & PCs
Autoskill Int'l, Inc. Academy of Reading, comprehensive **software** system, with management & testing components, to build literacy skills in children, teens & adults MD o
Broderbund **Software** , Inc. Just Grandma & Me, one of the Living Books Series MW o CD-i
Bytes...pre-K to 3) MW All About Me, family tree SW W o Great Wave **Software** Reading Maze (grades 3-7) MW o |

Hartley Courseware, Inc. Dr. Peet's Talk/Writer...

...Mifflin On Assignment, investigations in speaking, listening, writing, viewing & problem-solving (grades 6-8) *
Humanities **Software** Just Grandma And Me, a WRITE ON! Multimedia Study Bundle w/ network/site-licensed SW...

...Schuster Interactive Alistair & the Alien Invasion, intergalactic scavenger hunt (grades K-4) MW o
Smartek **Software** WordSmart Vocabulary Builder (grades 5+) DMW o |
Tesco Research, Inc. GOcabulary, in a game format...

...DW o Great Mystery Classics, Great Poetry Classics, etc, DW o
Mathematics
ABC/EA Home **Software** Counting On Frank, real-life math problems games (grades 3-7) WM o
Addison-Wesley...Inc. f(g) Scholar, combo of graphing calculator spreadsheet (grades 7+) MDW o |
Great Wave **Software** Number Maze (K-7) MW o | Decimal & Fraction Maze (grades 3+) MW o | KidsMath (pre...

...o | Memphis Math, with an Egyptian theme (grades 3-9) W ON
Music
Ars Nova **Software** Practica Musica 3, music ear training/theory tutor (grades 9+) M Songworks, songwriter's composition tools (grades 9+) M
Dr. T's Music **Software** Composer Quest W Sing-A-Long W o
Encyclopaedia Britannica Educational Corp. The Music Collection...

...o Other CD titles
Sumeria OceanLife II: Micronesia Vols 1 & 2 MW o Explore the **Maya** MW Other CD photo sets of nature & places
Videodiscovery, Inc. Understanding Earth, works with MediaMAX...
ABC-CLIO, Inc. EXEGY: The Source for Current World Information W o
ABC/EA Home **Software** 3D Atlas, 16 globes offer multi-dimensional view of world & its people (grades 3+) MW...

...hypertext design (grades 12+) W o
McGraw-Hill, Inc. McGraw-Hill Science & Technical Reference Set, **Release** 2.0 W o McGraw-Hill Multimedia Encyclopedia of Science Technology W o
Medio Multimedia...

...areas that apply to learning (pre-K-adult) odownload Training Media Database download
Now What **Software** Small Blue Planet: The Real Picture Atlas (grades 6+) MW o Small Blue Planet: Aerial...

...grades 6+) MW o
Osborne/McGraw-Hill That's Edutainment!: Parent's Guide to Educational **Software** (grades 12+) MW book/CD
Philips Interactive Media The Titanic (grades 8-12) CD-i...

...o
Simon & Schuster Interactive Macmillan Dictionary for Children (grades K-5) MW o
The Follet **Software** Co. informationplus, pkg of selected CDs--current events, music, literary, vocational reference (K-12) D...

...of the Future Series, additions to Home Library DW o
Science

A.D.A.M. **Software** , Inc. A.D.A.M. Essentials, fundamentals of human anatomy & the body's functions (K...
...interface for Macs & PCs CD-i titles feature CD-instructor interface teacher-support materials

AJ **Software** & Multimedia Physics of the Atomic Age MW o

Arnowitz Studios Concepts of Biology, year-long...

...includes player for Mac & Windows.

Terrific Teaching Tools

Merit Audio Visual has been producing educational **software** for more than 10 years. Our programs have been proven to help students sharpen their
...CD Server

CD-ROM networking technologies for information retrieval and management using dedicated servers and **software** for Novell, Banyan, NT, NetBIOS and peer-to-peer local area networks. CBIS CD-ROM...

...details arranged by curriculum subject so that you can compare and select easily. From Educational **Software** Institute, your one-stop shop for all multimedia. Phone 800-955-5570.

Spigot Power AV...

...s Internet AlphaServer Systems combine Alpha's 64-bit RISC performance with pre-installed Internet **software** . Each comes factory installed with Digital's unique ELECTRONIC LOCKER TM| system administration **software** . Designed with input from educators, it provides quick set up and straight-forward menus for...

...the servers via a point-and-click Mosaic client interface.

Lawrence Productions Catalog of Educational **Software**

Lawrence Productions creates interactive learning experiences for children and adults through the use of computer **software** . These adventures expand the logical thoughts, language, communication and life skills of users in a...

...Make your classroom or library the hub of learning activity with the best in new **Software** , CD-ROMs, Site Licenses, Lab Packs, School Versions, Curriculum, Technology, A and Furniture Products. Special **software** pricing for education customers FREE mouse mat with qualified purchase. (800) 356-1200

Smith System...

...with Professor Piccolo, offering you and your youngster a terrific head start in music.

Learning **Software** Designed for Schools

Bytes of Learning designs high quality **software** specifically to meet the needs of students and their teachers. InSight TM|provides interactive career exploration with personalized printouts. UltraKey TM| provides complete keyboarding instruction using **animation** and voice. UltraWriter TM| develops writing skills through hands-on writing. DOS, Macintosh and Windows...

...6428 for free evaluation copies. See us at NECC Booth #1 009-1011.

Free Demo **Software**

Great Wave **Software** invites educators to view our award-winning early learning, reading, and geography **software** designed for grades Prek-8. Customizing and tracking features make our products the perfect solution...

...video interface card, an external breakout box for external video and audio connections and comprehensive **software** . It captures signals from

any source and converts them to 24-bit color. PowerMac 8100/9150 recommended. Also includes VideoFusion, the leading postproduction special effects **software** application.

Sanyo LCD Projectors

Sanyo's Industrial Video Division has released two advanced-technology videoCD-ROM, interactive, multimedia **software** program that makes learning to read, write, listen to and speak English quick, simple and...
...find out more. (612) 739-5176.

Learning Expedition TM|

Ideal Learning's interactive curriculum based **software** for Macintosh or Windows provides complete sequences in Math, Reading and Language Arts for grades K-8. Teachers individualize assignments and track student progress through Ideal's Compass management **software** . Learning Expedition can be licensed for networks or standalone CD-ROM delivery.

Ideal Learning (800...

...all levels. The ELLIS curriculum combines graphics, full-motion video, digitized sound and voice recording, **animation** , and text in a user-friendly environment. For more information, call (801) 756-1011.

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...images, and an extensive student tracking and reporting system. Call (800) 448-6543

Special Education **Software** from Laureate

Laureate publishes the best special education **software** available. Our catalog offers a complete line of talking **software** for language, reading, and concept development. Great for Early Intervention, Preschool and Head Start, Developmental...
...meet educational goals. State-of-the-art multimedia--including digitized sound, full-motion video, and **animation** --provide interactive learning experiences for students at all grade levels. SuccessMaker is available on both...

...revolution has created new ways of presenting information and learning material. By integrating text, graphics, **animation** , sound and video, multimedia engages the senses and allows people to interact with information in...

...the industry is headed with consumer CD-ROMs."

Brainchild

A portable way to use educational **software** , at 1/10 the cost of a laptop! The Brainchild PLS-1000 Personal Learning system is a mini-computer with multi-lesson **software** cartridges. Study, score, review mistakes and many more functions. Interactive, self-paced study. No computer knowledge required. **Software** includes Kaplan SAT prep, Skills Bank basic skills for middle school - adult, Core Knowledge Sequence...number one in its class by InfoWorld. The server is a ready-to-use hardware/ **software** package with everything you need to use and manage your school's Internet connection. You...
...Encyclopaedia Britannica Educational Corp. Britannica Science System (BSS), (grades K-6) videodisc & activity pkg Falcon **Software** , Inc. Comprehensive Chemistry (grades 10+) D o Exploring Chemistry (grades 10+) MD o Environmental Science...

...Multimedia, physical science & chemistry videodisc/sw pkg Science & Technology Series videodisc/sw pkg

Great Wave **Software** Kids Time Deluxe (pre-K-3) MW o | World Discovery, geography (grades 3+) MW o...

...of microscopes (grades 5-12) M

McGraw-Hill, Inc. McGraw-Hill Science & Technical Reference Set, **Release** 2.0 W o McGraw-Hill Multimedia Encyclopedia of Science Technology W o

MECC World...

...series, videodisc-based curriculum with reading, writing & hands-on activities (grades K-8)

Physics Academic **Software** CUPLE: Comprehensive Unified Physics Learning Environment (grades 11+)

Pierian Spring **Software** Interactive Geography, customizable, teaches 5 main themes of geography (grades 4-9) M

Pyramid Film...Cinemar Corp. Presentation World, virtual seminar on creating delivering mm presentations (adults) W o

Falcon **Software** , Inc. Electronics Laboratory Simulator (grades 11+) D

Glencoe Publishing, Inc. Glencoe/Ives Multimedia System, teaches...

...for K-12 teachers to achieve instructional goals integrate technology into curriculum

PACE, Inc. Hardware & **software** kits for circuit board repair/manufacturing

PWS Publishing Co. VizAbility: Multimedia Tools for Visual Thinking...

...plus book & sketchbook suite M

VTAE Basic Electricity and DC Circuits/Basic AC Circuits *

Other **Software**

Agency for Instructional Technology (AIT) Teaching With Groups! inservice pkg V Other videodisc/sw bundles...all grades) W Mosaic In A Box, popular Web browser (all grades) W

The Follett **Software** Co. Sneak Previews Plus, for librarians D o Catalog Plus, online PAC search (K-12...

...790MHz, etc. Gateway 2000 486DX2/66, etc.

GVP-Great Valley Products Personal Suite Plus, hardware & **software** pkg for use with Windows, a PC, VCR & camcorder

IBM Corp. Ultimedia PS/2 M57...Systems

Avid Technology, Inc. Media Suite Pro 2.0, Desktop Digitial Video Editing System, hardware & **software** for Mac

FAST Electronics US, Inc. Video Machine, non-linear video

Horizons Technology, Inc. Power...

...record to another tape

Audio-Editing Systems

Avid Technology, Inc. AudioStation, digital audio workstation AudioVision **Release** 2.5, multi-track digital audio workstation Media Composer, turnkey nonlinear online video editing system...players available, including LC-V330 Level Ill AutoChanger System Bar'n'Coder Version 3.0 **software** M LaserBarcode Tool Kit 2.0 **software** D

Sony Education Systems MDP-1700 AR Multi Disc Player, multi-format videodisc/CD player...Polaview 3000 Polaview 1800 Polaview 1500

Proxima Corp. Ovation 810 active-matrix, tor text, graphics **animation** Ovation+ 842, active-matrix computer & video images ColorWorks, affordable for text, graphics **animation**

Sayett Technology, Inc. Datashow color LCD panels

Sharp Electronics Corp. QA-1500, operates without being...

...VP video presenter

Mind Path Technologies Mind Path IR90, computer remote with mouse control and **software** for DOS & Windows

Presentation Electronics, Inc. SilentPartner, multimedia remote control ProPresenter, remote control ProPresenter Plus...

...Elo Touch Systems, Inc. IntelliTouch touchscreens (surface acoustic wave) AccuTouch touchscreens (resistive) Plus controllers, drivers, **software** & complete "plug & play" TouchMonitors MonitorMouse, mouse-emulation sw WDM

MicroTouch Systems, Inc. TruePoint Touch Monitors...Alpha Systens Lab, Inc MegaMotion video capture & playback DW

BCD Associates, Inc. BCD-2000A professional **animation** controller 6 BCD-5000 video **animation** controller (any computer-to-any video machine) BCD-1000 video tape controller

Cardinal Technologies, Inc...

...Video, playback card with upgradability to MPEG Other cards available

Diaquest DO-TACO (Video Toaster **Animation** Controller) Series II external rack-mount **animation** controller Q-Animaq **animation** controller M

Digital Vision, Inc. ComputerEyes/1024, hi rez color video frame grabber DW ComputerEyes...to-video encoder Dit video overlay & graphics pan/zoom D

Matrox Electronic Systems, Ltd. Matrox **Animation** Xpress (MAX), digital **animation** recording from hard disk in real time D Illuminator-PRO, uses 4:2:2 digital...

...accelerator Pegasus VL & other graphics accelerators

Studio Magic Corp. Personal Video Studio, add-in card & **software** for low-cost desktop video W

Sun Microsystems, Inc. VideoPix for Sun workstations & video capture ...

...OW DVA-4000, DVI DM MediaSpace, digital video compression DW MediaSpace Playback Videomedia, Inc. Animax, **animation** & editing control for serial videotape/disc recorders D Amiga Express, single-device controller for frame-accurate **animation** , rotoscoping & authoring (any platform) V-LAN-CX, modules for control of "prosumer" camcorders & VTRs (any...

...other apps

VideoLogic, Inc. MEDIATOR, desktop print-to-tape box Multimedia Interactive Control (MIC) System, **Version 2** .2 D

Videomedia, Inc. V-LAN-CX, modules for control of "prosumer" camcorders & VTRs (any...Internet connection

Campus Learning Systems, Inc. Interactive multimedia development & delivery systems

CBIS, Inc. CD Connection **software** CBIS CD Server, dedicated CD server

CENTEC Corp. Centec Touch Reading Learning System (ILS) Archway...

...16-channel), a touchscreen-based system for sharing routing multimedia

ITC Activ Multi-User Network **Software** , use for ITC's Activ training system

Jostens Learning Corp. Jostens Learning First, multimedia ILS...

...Installation Utility sw for Windows LANcity Personal Cable TV Modem

Lotus Development Corp. Lotus Notes, **software** -based groupware environment that supports mm attachments

Minicom Advanced Systems CLASSNET, control, interaction & multimediasharing systems...

...Infochannel Master Workstation, an Amiga 4000/040 for creating TV programs InfoChannel IC400, multimedia communication **software** for authoring TV programs *

Sony Electronics, Inc. LLC9000 Language Learning System, with TECH Electronics' Commander...

...audio teleconferencing
Future Labs, Inc. TalkShow, document conferencing sw DW VIS-A-VIS, audiographic conferencing **software** MDW VIS-A-VIS Data Bridge D
Human Designed Systems HDS netVideo 2.0, multimedia...

...ProShare, family of personal and group video-conferencing products W
ITC Activ Multi-User Network **Software** , for use in conjunction with ITC's Activ system Lotus Development Corp. Lotus Notes, **software** -based groupware environment that supports mm attachements
MultiLink, Inc. System 70, a teleconferencing system that...

...based videoconferencing rollabout & 486 Windows workstation
Northern Telecom, Inc. VISIT videoconferencing systems VISIT Access, teleconferencing **software** MOW
Panasonic Broadcast & Television Systems Co. VisionSeries 50, executive-level tabletop videoconferencing system VisionSeries 300...Shure Consensus ST2500, portable, full-duplex digital audioconterence system
Silicon Graphics, Inc. Inperson, desktop videoconferencing **software** U
Sony Electronics, inc Trinicom 2000 rollabout videcconterencing systems, with 27" display, one-touch trackball...

...VP, DOS-based, Mediamax platform D Mediamax 3.01 & MCU-II 1.1, upgrades to **software**
Miscellaneous
Bretford Manufacturing, Inc. Computer labs & A/V furniture, carts & stands, projection screens, TV mounts...

...services for CD-ROMs & videodiscs
AC&E, Ltd. Integrators of videoconferencing, distance learning & multimedia applications; **software** developers specializing in communication systems interface control
American Technology Resources Systems integrator for optical disc...

...Ameritech Telecommunication technologies: distance learning & networking of multimedia in Illinois, Ind., Mich., Wisc. & Ohio
AMT **Software** Custom development of CBT for medical education, manufacturing & industry
BCD, Inc. Complete CD-ROM mastering...

...BERMAC Communciations, Inc. Consulting, design, production & programming of custom interactive multimedia, digital or analog, hardware & **software** independent
Bolt Beranek and Newman, Inc. Hardware & **software** turnkey packages to create utilize an internet connection
Caption Connection Provides open- and closed-captioning...

...online help, IntoZap sends student application to school
CompCore Multimedia, Inc. Offers license to SoftPEG **software** , an MPEG-1 decoder that runs on PowerPC, MIPS & Alpha systems
CompuVid, Inc. Systems integrators...

...connectors, cards, patch panels, transmitters receivers Digital Learning Services Multimedia training packages and services Educational **Software** Institute, Inc. Offers over 7,000 K-12 titles with personal selection help
Electronic Multimedia...

...post-production & pre-mastering services of Level I, II & III|videodiscs
Horizons Technology, Inc. Multimedia **software** development & systems integration
Imagine Tomorrow, Ltd. Multimedia Learning Centers
institute for Academic Technology IAT offers...

...CBT thru consulting, development services & user training; develops custom interactive multimedia OBT apps
Michael Jackson **Software** , Inc. Multimedia-based training & CBT custom development
Multimedia PC Marketing Council Publishes the Multimedia PC specification & licenses the MPC trademark to firms whose systems, **software** & peripherals meet specs
Optical Disc Corp. Makes recordable videodiscs (RLVs)
Optical Media Int'l Complete...Educational Resources 1550 Executive Dr. Elgin, IL 60123 (708) 888-8300 (800) 624-2926 Educational **Software** Institute, Inc. 4213 South 94th St. Omaha, NE 68127 (402) 592-3300 (800) 624-5570
Educational **Software** Institute, Inc. 4213 South 94th St. Omaha, NE 68127 (402) 592-330 (800) 955-5570...

...Sciences Consortiium 201 Silver Cedar Court Chapel Hill, NC 27514-1517 (919) 942-8731
Humanities **Software** 408 Columbia, #222 Hood River, OR 97031 (503) 386-6737 (800) 245-6737
Image Entertainment...

...Blvd. Austin, TX 78726-9000 (512) 984-1800 (800) 328-1371
A.D.A.M. **Software** , Inc. 1600 Riveredge Pkwy., #800 Atlanta, GA 30328 (404) 980-0888 (800) 755-2326 adam...

...ROM Inc. 475 Sackett Lake Rd. Monticello, NY 12701 (914) 794-5178
ABC/EA Home **Software** 1450 Fashion Island Blvd. San Mateo, CA 94404 (415) 571-7171
AC&E, Ltd. 14101...l. Corp. 47971 Fremont Blvd. Fremont, CA 94538 (510) 226-8960 (800) 882-8184
AJ **Software** & Multimedia 1036 South Holt, #2 Los Angeles, CA 90035 (310) 657-4038
ALCHEMEDIA, Inc. 1679...

...2000 W. Ameritech Center Dr., Room 4A43D Hoffman Estates, IL 60196 (800) 942-3395 AMT **Software** (Advanced Multmedia Training) 2680 Chandler Ave., #1 Las Vegas, NV 89120-4024 (702) 369-4321...

...426-5355
Arnowitz Studios 1 Harbor Dr. Sausalito, CA 94115 (415) 332-5555
Ars Nova **Software** 550 Kirkland Way, #140 Kirkland, WA 98083 (800) 445-4866 arsnova@applelink.com Artbeats Box...Bright Star Technology, Inc. 40 Lake Bellevue, #350 Bellevue, WA 98005 (206) 451-3697
Broderbund **Software** , Inc. 500 Redwood Blvd. Novato, CA 94948-6121 (800) 521-6263
Brother Int'l. Corp...Ave. New York, NY 10016 (212) 213-4800 (800) DKM-M575
Dr. T's Music **Software** 100 Crescent Rd. Needham, MA 02194 (617) 455-1454
DSP Solutions, Inc. 2464 Embarcadero Way...

...Inc. PO Box 392 Freeport, NY 11520 (516) 223-4666 (800) 645-3739
Education Interactive **Software** Institute, Inc. 39833 Paseo Padre, #G Fremont, CA 94538 (510) 659-7964

Software Man, Inc. 3933 Steck Ave., #B115 Austin, TX 78759-8648 (512) 346-7887

SOLEIL **Software** , Inc. 3853 Grove Court Palo Alto, CA 94303 (415) 494-0114

Sony Electronics, Inc. Sony...

...Products 2402 Advance Rd. Madison, WI 53704 (608) 221-1155 (800) 279-2003

The Follett **Software** Co. 1391 Corporate Dr. McHenry, IL 60050-7041 (815) 344-8700 (800) 323-3397

The...Vision River PO Box 451148 Atlanta, GA 31145 (404) 394-1000 vision@aol.com

Visual **Software** , Inc. 21731 Ventura Blvd., #31 0 Woodland, CA 91364 (818) 883-7900 (800) 669-7318...

...D Concord, CA 94520 (510) 674-0783 (800) 786-9907 orders@cdrom.com

Walt Disney **Software** 500 S. Buena Vista St. Burbank, CA 91521 (818) 841-3326

Warner New Media 3500...

...DESCRIPTORS: **Software** Buyers' Guide

9/3,K/10 (Item 1 from file: 636)

DIALOG(R)File 636:Gale Group Newsletter DB(TM)

04519337 Supplier Number: 58376271 (USE FORMAT 7 FOR FULLTEXT)

Video: Leading the way into the new millennium.

World Broadcast News, pNA

Dec, 1999

Language: English Record Type: Fulltext

Document Type: Magazine/Journal; Trade

Word Count: 5344

... ADR beep generator.

Editing Accom Accom released the Affinity nonlinear editing system and Dimension.8 **software** . The Affinity is a real-time uncompressed digital 601-editing, effects, compositing and ...uncompressed or compressed video that can be mixed to quality vs. storage time.

Dimension.8 **software** for Affinity offers true 3-point insert/overwrite/fit-to-fill editing, clip pinning and...save preset video and audio track sizes in the NewsCutter timeline.

The company also debuted **version 2** of the Avid Symphony nonlinear editorial finishing system. With the new 24P Universal editing and... 24-frame progressive content in its native format.

The Symphony Universal model, also released with **version 2** , addresses the challenges of producing multiformat, multiversion content. It offers the ability to pan and...

...3, NTSC, PAL and letterbox versions of TV projects.

In addition, Avid presented Avid Xpress **version 2** .5 for the Macintosh platform. The digital real-time nonlinear editing system incorporates Avid's...showcased a new set of features for video and audio editing in its FAST-Studio **software** . In addition ...in Zip and CD-ROM drives, three PCI slots for expandability and version 4 editing **software** . The 2000 supports both on-line and off-line editing at multiple compression levels and has real-time audio mixing. Other features include a main signal processing unit, application **software** , 21-inch SVGA monitor, art tablet and advanced control panel.

Philips Digital Video Systems Philips...such as promos, stings, titles and programs.

Quantel also showed a new version 7.6 **software release** for Editbox FX, Henry and Infinity that will integrate the new tools into the 7 ...optical components.

Recorders/Servers AFA Products Group AFA Products Group offered Trax'im, tracking AI **software** designed to perform high-level sensory tasks. It tracks the outline of objects in motion...playout server with third-party automation systems, or with EVS' clips acquisition and playlist management **software** , in single or multi-program environments.

The CDM-1 is an MPEG-2 4:2...is designed for automation in transmission environments and is a quality alternative to PC captioning **software** . MOTTO features full 32-bit color, Postscripts and TrueType font compatibility; a custom-designed keyboard; and a 2U rack-mount mainframe.

Avid Technology Avid offered its next-generation 3-D **animation** solution, Sumatra. The nonlinear **animation** system features non-destructive **animation** mixing, interactive rendering and real-time surface continuity management. Consistent with other Softimage tools, Sumatra as in the design and interactivity of individual tools.

Avid also released **version 2** .0 of the Softimage Marquee system, a resolution independent 3-D titling **animation** system that combines true 3-D **animation** capabilities with real-time interactivity and an intuitive Avid-style timeline. New features include a...

...shape creation.

Boris FX Boris FX introduced Boris Graffiti, a 2-D/3-D-title **animation** plug-in application for nonlinear editing applications on both Macintosh and Windows NT platforms. It...wide range of manufacturers, including Avid, Discreet, Media 100 and FAST. The resolution-independent title **animation** module allows title treatments such as individual character **animation** and rotations with animated tracking, extrusions, light sources, and video texture mapping.

Likewise, Boris FX...create with a range of effect tools, including keyers, mattes, blurs and color correctors.

Cambridge **Animation** Systems Cambridge **Animation** Systems unveiled Animo 3, 2-D production **software** that provides a gateway to seamless, interactive integration with 3-D models. It is embedded...files from two 3-D packages -- Kinetix's 3D Studio MAX and Alias/Wavefront's **Maya** . Scene III creates an environment in which 3-D models, cameras, special effects and lighting...DVE channels and videos sources.

Pinnacle Systems Pinnacle Systems presented the Rocket for FXDeko, a **software** option for the FXDeko character generator system. Rocket is a template-based tool that allows...at high-speed as a background task.

Realviz Realviz released its Image Processing Factory (IPF) **software** . IPF is designed for computer graphics, **animation** and special-effects professionals seeking to integrate conventional live-action footage with 3-D computer-generated **animation** . The four integrated **software** applications in IPF allow users to create high-quality 3-D animations while simultaneously enhancing...

...results for final rendering.

Virtual sets Evans & Sutherland Evans & Sutherland announced that LinkPAC, an optional **software** feature for MindSet Virtual Studio System, is available as part of the FuseBox 4. 0 update. LinkPAC allows users to create data displays and **animation** effects within a virtual studio. Links can be created easily to control the effects of...

PRODUCT NAMES: 3573293 (Computer Graphics, Sound and Video Processors); 3661257 (LAN/WAN Adapters); 7372452 (Desktop Video **Software**)

SIC CODES: 3577 (Computer peripheral equipment, not elsewhere classified); 3661 (Telephone and telegraph apparatus); 7372 (Prepackaged

software)
NAICS CODES: 334119 (Other Computer Peripheral Equipment Manufacturing); 33421 (Telephone Apparatus Manufacturing); 51121 (**Software** Publishers)

9/3,K/11 (Item 2 from file: 636)
DIALOG(R)File 636:Gale Group Newsletter DB(TM)

04397223 Supplier Number: 55350135 (USE FORMAT 7 FOR FULLTEXT)
Siggraph '99: Coming Home to California.
Millimeter, pNA
July, 1999
Language: English Record Type: Fulltext
Document Type: Magazine/Journal; Newsletter; Trade
Word Count: 4415

... the Wildcat 3D graphics technology in its new PowerStorm 600 graphics card, adding its own **software** innovations to the Intense3D chips.

Intergraph notes that, earlier this year, the Wildcat 4000 achieved ...

...conforms a broader range of effects indicated in Composer and Symphony files. Avid Marquee 3D **software** , available as a plug-in, enables 3D titles and **animation** . Finally, all standard audio sample frequencies are supported when reading files, which allows better sequence...

...Avid's Softimage division will demonstrate the continued evolution of Sumatra, along with the current **release** , Softimage...
...3D v.3.8 SP2, which now incorporates **Version 2** .1 of the Mental Ray renderer. New effects include: Lightning, Little Fluffy Clouds, Baked Earth ...

...Wavefront unveiled a revolutionary price/performance product at NAB '99 in **Maya** Complete (SGI/Win NT). With a list price of $7,500, the **animation** and effects package offers the company' s highly regarded 3D modeling, rendering, and **animation** technology at near entry-level pricing. (The earlier versions of **Maya** ranged from $15,000 on up.) However, Discreet's 3D Studio MAX, at approximately $3,500, still bests the Alias product for true entry-level graphics and **animation** .

Other capabilities of **Maya** Complete are an explosive-type particle effects system with integrated soft-body dynamics and Artisan...

...Wavefront claims this will eliminate the need for multiple test renderings.

Also introduced: **Maya** Fusion, a $5,000 nonlinear compositing and video effects **software** package (Win NT). Co-developed with Eyeon **Software** , (whose Digital Fusion offers many of the same capabilities), **Maya** Fusion joins the integration trend of building 3D **software** systems around nonlinear edit packages. Here, Eyeon's 2D editing, compositing, and effects integrate with **Maya** Complete's 3D **animation** tools. There's support for industry-standard plug-ins and file formats for further integration...

...sprung from repurposed defense contract work. As if from some science fiction future, this rarefied **software** (at the time only an SGI Onyx with specialized hardware could run it) pulled out...

...shipping expected in August).
Employing its Visual Stream Analysis (VSA) technology, SynaPix spots the hardware/ **software** combo for 3D analysis, compositing, and choreography. (The Virtual Theatre, a 3D workspace, enables users...

...objects in realtime and keep any audio synch intact.)
Also shipping: MatchMaker 3D match-moving **software** (SGI platform, $8,600). By analyzing film or video sequences, this program extracts a camera...

...geometry. Users then output this info to either SynaPix or any of the leading 3D **animation** programs.
After its prolonged development stage, SynaPix is pushing for rapid growth. (The company was...
...Wavefront's **Maya** . Currently, Intergraph's StudioX has won an exclusive as the only designated Win NT platform...

...acquired Alchemy 3D, providers of the camera path and point geometry engine employed in the **Maya** Live program.
Discreet will show 3D Studio MAX **Release** 3, with a completely rewritten renderer and expanded spline and patch modeling. Improved character **animation** tools offer skinning, secondary motion, and morphing along with access to source code (for anyone...

...interactively adjustable to give immediate feedback for making artistic decisions.
Blocks allows users to manipulate **animation** sequences like clip art from potential libraries of **animation** . Users can cut, paste, combine, blend, and time **Animation** Blocks in a paradigm similar to nonlinear video editing.
Surface Tools, the popular Digimation product...

...HD resolutions. The card supports the company's new DYNAMIC geometry driver architecture. The driver **software** dynamically uses multiple workstation resources to accelerate OpenGL geometry processing and data movement by using...and also all layers created in Adobe Illustrator).
Along with popular Photoshop filters, Alien Skin **Software** introduces Xenofex 1.0. This collection of 16 special effects for Photoshop and other graphics...

...out Eye Candy for After Effects. The product contains a powerful set of video and **animation** effects that are surprisingly easy to use.
Digimation shows its entire line of Discreet 3D...

...multimedia), and RETAS (a widely used 2D cel and paint system for traditional animators).
Arete **Software** -the company that brought you Digital NatureTools, Psunami, and Psyclone-will unveil the latest plug...

...controlling the water's distortion.
Among the extensive features for Psyclone (v.1.0 for **Maya**), the latest NatureFX tool, are advanced 3D fly-through volumetric clouds, smoke, and other pyroclastic...effects package. RED adds displacement mapping, motion blur, particle generation (clouds and smoke), 3D title **animation** , and the ability to incorporate any Adobe After Effects plug-in to the capabilities of...

...intent upon breaching its "black box." Now, Surrey, England-based 5D, a developer of effects **software** for IRIX and NT platforms, released Masher for Quantel systems at NAB '99. (Quantel refers...

...open network.
Also new is an entry-level Hal with the latest Version 6.0 **software** and five minutes of uncompressed storage. Look for updates to the Paintbox FAT **animation** system (a 16:9 ready system capable of 5,000 frames of uncompressed storage for...

...for video games and DVD-ROM projects-make it another unique price/performance piece of **software** to be delivered by the Scotts Valley, California-based company.
Bryce 4.0 can export fully textured terrains to virtually all 3D modeling/ **animation** formats, such as MetaCreations' Ray Dream Studio (.rds), Infini-D 4.5 (.id4), and NewTek...

...extensive range of object import formats for greater compatibility with other high-end 3D modeling/ **animation** applications.
Within Bryce 4, artists and animators have expanded abilities to create and animate realistic...

...multiple CCD cameras that each aim at a different part of the mirror set. The **software** combines the images and displays a seamless ... Although IRIX is by far the most popular UNIX system for top 3D graphics and **animation** programs, it still runs only on SGI machines, while Windows NT keeps coming on strong...

...rival Sun's Java 3D API. The Java API (Application Program Interface, a sort of **software** "hook") yields a rich feature set, and, since it is a higher-level programming device...

...TB. SGI also released its GLX and OpenVault technologies to the open-source community. (OpenVault **software** helps SANs deal with removable media.) Also, moving toward an agnostic "total-solutions" stance, SGI...
PRODUCT NAMES: 7372440 (Graphics **Software**)
SIC CODES: 7372 (Prepackaged **software**)
NAICS CODES: 51121 (**Software** Publishers)

9/3,K/12 (Item 3 from file: 636)
DIALOG(R)File 636:Gale Group Newsletter DB(TM)

04187635 Supplier Number: 54779840 (USE FORMAT 7 FOR FULLTEXT)
Hotware; A Review of New Products.
Ochiva, Dan
Millimeter, pNA
May, 1999
Language: English Record Type: Fulltext
Document Type: Magazine/Journal; Newsletter; Trade
Word Count: 1722

In the meantime, **release** 4.0 of BeOS ($100 list) could possibly be the best multimedia operating system ever...

...there is no need to make an all-or-nothing decision about implementation. A simple **software** "boot manager" program allows booting up in one or the other program.
The **software** , designed from the ground up to handle graphics, audio, and video in realtime, simply has...

...easy-to-use interface and development system. Hundreds of programmers

worldwide turn out low-cost **software** and freeware for BeOS, including MAXON with its CINEMA 4D. MAXON's raytracer, released in a completely rewritten version in 1996, is a 32-bit, object-oriented 3D modeling, **animation** , and raytracing package. Multi-processing and multi-threaded, the **software** is efficient, providing a 370-percent speed increase on a four-processor system. The successful program is now part of a family of 4D products.

Be has expanded support for **software** standards (e.g., AVI, color-printer drivers) and hardware devices such as display adapters, video ...

...462-4141, or visit the Web site at www.be.com.

Xytech Updates Facility Management **Software** Burbank-based Xytech Systems has made business operations **software** for the media and entertainment industries since its founding in 1988. Now, Xytech has released **version** 2 .0 of Enterprise, its flagship product. The **software** runs on Windows 95/98/NT or Macs and over standard Web browsers. It supports...

...card, duplication, rental, accounts receivable, accounts payable, banking, and general ledger. One useful point: The **software** works with pre-existing databases.

For more information, contact Xytech at (818) 767-7400, or...
...s MPEG TOOLBOX-2, which some say is the industry's first integrated MPEG-2 **software** encoder/editor for Windows 95/98/NT.

A low-cost editing setup is the result...

...sided disc (2.6GB/$25) comes in a removable cartridge. VITEC's plug-and-play **software** package comes bundled with its award-winning Multimedia Video Clip MPEG-2 "SE" Editor. Video...

...and generates a new MPEG-2 sequence.

You can buy VITEC's MPEG TOOLBOX-2 **software** ($249 list) worldwide or download it from VITEC's Web site: www.vitecmm.com. The **software** converts AVI files into MPEG-1 and MPEG-2 audio, video, and data streams at ...

...800) BELDEN-4, or visit the Web site: www.belden.com.

Charybda's DIVER Batch **Software** for SGI A number of years ago, Arroyo Hondo, New Mexico-based Charybda used its DIVER **software** to automate tedious tasks necessary for transferring files with Silicon Graphic's IRIX operating system...

...could output files to various tape backup systems for later transfer to D-1.

Now, **release** 3.3 of DIVER includes 10-bit YUV processing, matte-mode processing, and translation to and from Alias|Wavefront's **Maya** IFF file format. Charybda has improved file selection, ...776-1400.

JVC Updates Its Nonlinear Editing System JVC's TimeGate MW-S1000 nonlinear editing **software** has gone through some significant upgrades since its debut at NAB '98. Running under Windows...

...Movie-2 bus, delivers 40MB/second dual video streams. Features include audio and video scrubbing, (**software** -based) monitor/vectorscope, four real-time tracks (two video, one graphics, and a background), strobe...

9/3,K/13 (Item 4 from file: 636)
DIALOG(R)File 636:Gale Group Newsletter DB(TM)

04150912 Supplier Number: 54417584 (USE FORMAT 7 FOR FULLTEXT)
New Products.
Video Systems, pNA
April, 1999
Language: English Record Type: Fulltext
Document Type: Newsletter; Tabloid; Trade
Word Count: 4482

... supports D1, 480i, 720P, 1080i, 24frames/s to 30frames/s, and 2K/4K film. The **software** supports the full color space of images scanned by both high-end film scanners used...

...providing more than 300 real-time effects. No rendering is required for these transitions. The **software** bundle includes Adobe Premiere 5.0, TitleDeko titling **software** with Pixelan **Software** 's Video SpiceRack effects, and Sonic Foundry's ACID music works. Price: $2,499. (Mountain...

...pinnaclesys.com)
Graphics Production Duo By Chyron Duet/Lyric: Lyric provides full text, graphics, and **animation** capabilities in an object-oriented program. The **software** includes user tools, such as browsers, timelines, preferences, undo, spell check, and online help. It...

...in the form of the Time Machine dual-channel card and the accompanying Preditor NLE **software** . Built around a wavelet-compression architecture that the company claims is visually superior to M...

...integrates with other parts of Trinity. For example, with Time Machine, Trinity's paint and **animation** system, Panamation, can deal directly with multiple streams of D1 video for compositing, keying, and...

...a single Time Machine card. (Rancho Cordova, CA; 916-851-0800; www.play.com)
SGI **Animation** By Alias|Wavefront **Maya** Unlimited: Targeting high-end animators in both film and video, Alias|Wavefront has unveiled **Maya** Unlimited, an integrated suite of the company's most sophisticated **animation** , modeling, and rendering tools. It combines all the functionality of the recently announced **Maya** Complete **software** (which is available for both SGI and NT platforms) with a suite of custom applications, including: **Maya** Live for live-action match moving, **Maya** Fur for fur and hair design, **Maya** Cloth for clothing and fabric simulation, and **Maya** PowerModeler for NURBS modeling. The program runs on SGI IRIX workstations. Price: $16,000. (Toronto...Web developers can export high-quality, low-bandwidth video directly to the Web. The RealProducer **software** creates HTML-ready audio and video content for websites and uses Netscape RealPlayer plug-ins...

...Price range: $5,995 to $9,995. (Marlboro, MA; 508-303-4781; www.media100.com)
Animation and Terrain Generation By MetaCreations Bryce 4: Highlights of this **release** include new web functionality, along with the ability to export scenes to HTML with image...

...Lab. Users can also generate fully animated, fully rendered thumbnail previews of animations in the **animation** area. The **software** also offers new and improved object-import options and new 3D-file-format support for ...

...Carpinteria, CA; 805-566-6274; www.metacreations.com)

MPEG-2 Encoder By Vitec Multimedia MTB2: The MPEG Toolbox-2 **software0** kit can turn any AVI capture board into true MPEG-2 digital video and will ...CA; 408-752-8483; www.vitecmm.com)
Encoder/Reformatter By Charybda DIVER 3.3: This **software** for the SGI IRIX platform enables batch-image operations and transfer to and from most...

...3.3 includes 10-bit YUV processing and translation to and from Alias/Wavefront's **Maya** IFF. Price: $1,500 (single machine license). (Arroyo Hondo, NM; 505-776-1400)
Videocassettes By...
PRODUCT NAMES: 3573293 (Computer Graphics, Sound and Video Processors); 7372452 (Desktop Video **Software**)
SIC CODES: 3577 (Computer peripheral equipment, not elsewhere classified); 7372 (Prepackaged **software**)
NAICS CODES: 334119 (Other Computer Peripheral Equipment Manufacturing); 51121 (**Software** Publishers)

9/3,K/14 (Item 1 from file: 810)
DIALOG(R)File 810:Business Wire

0841824 BW0189

Business Wire Recap

April 27, 1998

Byline: EDITORS

...Eve of National Infomercial Debut (BW0117 09:03)
(WARREN-FORTHOUGHT) HOUSTON--Warren-Forthought's MocKingbird **Software** Adds Support For Oracle and Microsoft SQL Server (BW1290 09:04)
(ENTEX-INFORMATION-SERVIC) RYE...

...Servers (BW1300 09:06)
(DATACARD-6) WASHINGTON, D.C.--DataCard Debuts Image and Data Retrieval **Software** for Enterprise Applications (BW0129 09:06)
(HGA) MILWAUKEE--New Mercy Medical Center Sets Example for...as Vice P resident of Finance and CFO (BW0132 09:07)
(BENTLEY) EXTON, Penn.--Third Major **Release** of MicroStation TriForma Brings "Any Shape" to Heralded Single Building Model (BW0133 09:07)
(DBA- **SOFTWARE**) NEW ORLEANS--Y2K!Tools **Version** **2** .0 Now Processes COBOL and CA-ADS Simultaneously; Y2K!Tools Help Companies Become Year/2000...

...IPASS) SAN JOSE, Calif.--VPNet Technologies Offers Global Remote Access Service Through Integration of iPass **Software** (BW0137 09:08)
(SONY-INTERACTIVE) FOSTER CITY, Calif.--NFL Xtreme is Playstation's First Arcade...

...MEXICO CITY--Grupo Posadas Announces $50 Million Construction of Three Hotels in New Riviera/Costa **Maya** Districts (BW1328 09:14)
(MICROSTRATEGY) VIENNA, Va.--MicroStrategy Introduces DSS Web

13/3,K/1 (Item 1 from file: 15)
DIALOG(R)File 15:ABI/Inform(R)

00617974 92-33076
Evaluate Health Plans
Marshall, Leslie; Howe, Nancy
HRMagazine v37n5 PP: 36-40 May 1992
ISSN: 1047-3149 JRNL CODE: PAD
WORD COUNT: 1126

...TEXT: CALC

WTR DATA SERVICES 630 Third Avenue New York, N.Y. 10017 (212) 949-8989

VERSION : 2 . 1

RELEASE DATE : January 1991

APPLICATION : The system asks a series of questions on the provisions of a plan and then...

13/3,K/2 (Item 1 from file: 148)
DIALOG(R)File 148:Gale Group Trade & Industry DB

05926378 SUPPLIER NUMBER: 12719519 (USE FORMAT 7 OR 9 FOR FULL TEXT)
Persuasive presentations. (Persuasion for Windows) (Software Review) (PC Power) (Evaluation)
Entner, Mike
HRMagazine, v37, n6, p36(4)
June, 1992
DOCUMENT TYPE: Evaluation ISSN: 1047-3149 LANGUAGE: ENGLISH
RECORD TYPE: FULLTEXT
WORD COUNT: 1215 LINE COUNT: 00097

... opportunity.
Persuasion
Aldus Corp. 411 First Ave., South Seattle, WA 98104-2871 (206)622-5500
Version : 2 . **1** **Release Date** : **Application** : Price: $495-00; competitive upgrade is $99.00. Current users of Persuasion V2.0 may...
?

20/7,K/1 (Item 1 from file: 16)
DIALOG(R)File 16:Gale Group PROMT(R)

06060143 Supplier Number: 55631961 (THIS IS THE FULLTEXT)
FRONT LINES.
PARISI, PAULA
Hollywood Reporter, v353, n24, pS-1
July 17, 1998
TEXT:

Already adept at building entire worlds, the effects industry now strives to do the little things.

Blame it on short attention spans or jaded post-modem sensibilities, but today's film and TV viewers are very attuned to the capabilities of digital special effects, and are ever-impatient for the next big thing. However, as the effects community plows ahead with mind-blowing new work, many industry movers and shakers are focusing their attention on the more "mundane" types of photorealistic effects, as well as the continuing effort to crank work out faster and cheaper.

This past year saw the movement of cutting-edge digital-effects work to a sort of familiar mainstream. Five years ago, Dennis Muren's CG dinosaurs were a revelation, and we were awed at the level of detail -- right down to how ribs and internal organs move underneath scaly dinosaur skin -- required to create such realism. By contrast, the equally impressive digital work on "Godzilla" had a bit of a "been there, done that" feel for many. This fall, DreamWorks' "Antz" and Pixar's "A Bug's Life" will pick up where the groundbreaking "Toy Story" first ventured. And with the wow of a first viewing of "Toy Story" gone, effects maestros are having to dig deeper to bring new wonders to the viewing public.

"Technically we've solved some of the big problems, but as far as creating characters that are interesting to watch or are funny or are making the most of being able to put on a performance, I don't think anyone s come close," says Kleiser Walczak Construction Company co-chief Jeff Kleiser. who recently completed a 3-D "Spiderman" attraction for Universal Studios. "For us as a company, the most exciting challenge is making characters that are believable, empathetic, fun to watch."

As the heavy hitters of the digital-effects community - and a healthy crop of up-and-corners - gather in Orlando, Fla., this weekend for the annual convention of the Special Interest Group on Computer Graphics (SIGGRAPH, running July 19-24), the hallways will be filled with talk of how to create the next big effect and how to create today's effects cheaper and faster. The convention will be packed with symposiums on such esoteric topics as "Advanced RenderMan: Beyond the Companion," "Virtual Humans: Behaviors and Physics, Acting and Reacting" and "Multiresolution Surfaces," and attendees will eagerly grab up the latest software releases.

And what bitstream broncos will Hollywood's digital wranglers be breaking next? High-fidelity hair, fur and especially fabric - seemingly mundane but surprisingly complicated problems - seem to be where the artists are setting their sights. Hair is hard mainly because it is incredibly complex, requiring the rendering of thousands of individual elements and attention to physical interaction. Fabric is a challenge because of the many different ways in which types of cloth move across three-dimensional objects. Though impressive, "Toy Story" carefully avoided hard-to-render moving cloth in favor of hard plastic toys.

The interplanetary creatures that populate George Lucas' "Star Wars" prequels, the leading ape in "Mighty Joe Young" - which will be closely intercut with Rick Baker's full-size animatronic work - and the nattily attired mice of "Stuart Little" are among the characters that will put expertise in these areas to the test, with a raft of new applications and plug-ins coming out to help everyone tackle these effects.

To create the titular mouse of "Stuart Little," visual-effects

supervisor John Dykstra will also use a combination of techniques, including animatronics and puppetry, though many pivotal close-ups will be done digitally.

"Computers will play a big role in realizing director Robert Minkoff's vision for a group of mice who walk erect, wear clothes and emote," says Dykstra. "To that end, a big issue for us is giving him a consistent body language so he has body personality." Dykstra adds that Sony Pictures Imageworks will be using Alias/Wavefront's Maya software as the backbone of its effort. "We're going to create a range of facial expressions that convey that this is essentially a human face," he says. "What does a photorealistic mouse look like smiling? It will have to convey some really subtle emotions: the difference between a happy smile and an ironic smile."

Silicon Graphics' "digital evangelist" Linda Jacobson cautions that "a lot of these characters are really creepy to look at, and you run the risk of alienating audiences."

On a purely technical level, cloth is another big technical challenge. The industry is eagerly awaiting the debut of the Maya Cloth plug-in, due this fall. Marina Del Rey, Calif.-based Reflection Fabrix will also debut its Softimage accessory to handle similar work. Both will incorporate "cloth dynamics," automating the physics of fabric, so that once a garment is created and placed on a figure, the figure's motion will drive that of the fabric. This is an important feature that harkens back to similarly groundbreaking work on figure animation, when programmers learned how to let computers know that when a CG hand moved, the arm and shoulder moved with it. Quick and easy CG clothes may open the floodgates for the wider use of digital extras.

"Maya Cloth lets clothes work the way real clothes work. Everything else is just a hack," says Tom Williams, Alias! Wavefront vp and general manager. Williams says the biggest hurdle of the modem effects era - one he feels his company largely overcame in February, with the **release** of **Maya** - is the ability to shortcut the **animation** process. " **Maya** has really fast dependency graphs - embedded animation controls that allow you to program really complicated moves into a single keystroke, (sort of like animated macros). A character can have thousands of different parameters that you can animate: from rotating the head to moving the joints of the leg, the arm, adding hair and every other detail. It just builds and builds. You might have 30 controls you activate just to have a character make a fist. With Maya, you can condense that into a single control."

Williams notes that while Pixar and Pacific Data Images have been using homegrown versions of such software for years, Maya is the first package to offer it commercially.

On a broader level, the bigpicture players are citing areas like systems management, animation shortcuts and realistic motion as the big hurdles for programming pundits.

"The things that are easy to do in live action, like people, are hard for us and the things that are hard in live action, like explosions and space ships, we find easy," says Nicholas Napp, senior producer at the Phoenix, Ariz.- based Rainbow Studios, the first independent to tackle an all-CGI film. The $9 million "Blue Planet" - which he describes as "Star Wars" meets 'The Abyss" - is due out in 1999. (Its director, Tony Stutterheim, is a veteran of Amblin Imaging.) Virtually the entire film is being produced by 25 animators working on NT workstations (see "Chip Chat" on page S-18).

"We'll always be trying for more realistic images," says Industrial Light & Magic chief technology officer H. B. Siegel. 'That ocean is endlessly deep. But in terms of CGI characters, audiences are pretty satisfied with what they're seeing," 'They're not generally walking out of films like 'The Lost World' saying, 'I didn't like it because the dinosaurs didn't look real.' Among the big focuses for ILM as a company is the quality of animation - how these characters move.

The company has set up an inhouse motion-capture studio that draws on magnetic and optical systems, though it continues to use keyframe animation to mobilize its digital hordes.

As for the ultimate, or ultimately challenging, digital effect - the all-CG human character that remains some ways away. Putting a more human face on digital droids is a chief concern of Siegel's going into the "Star Wars" prequels.

"The human face has thousands of muscles, and their subtle interplay is enormously complicated," he says. "The interesting thing is that as your target creature becomes more and more human, you kind of have an inverse desire to animate it. If you can just go out and hire an actor, what's the point of doing it on a computer?"

... the modem effects era - one he feels his company largely overcame in February, with the **release** of **Maya** - is the ability to shortcut the **animation** process. " **Maya** has really fast dependency graphs - embedded animation controls that allow you to program really complicated...

20/7,K/2 (Item 2 from file: 16)
DIALOG(R)File 16:Gale Group PROMT(R)

05248543 Supplier Number: 47999936 (THIS IS THE FULLTEXT)
Net Gains
Kaufman, Debra
Hollywood Reporter, pS-28
Sept 23, 1997
TEXT:
While near software products abound, there's nothing like the good old-fashioned Internet for keeping animators working together.

DEBRA KAUFMAN

The hottest new tool for international animation may be the Internet. Just a few years ago, digital ink and paint systems (DIPS) were the latest word in toon technology. Now, DIPS combined with the Internet is the cutting edge. Take 'The King and I,' for example. This animated feature, directed by Rich Animation in Burbank for Morgan Creek Productions, signed on freelance animators and animation studios around the world, including Pentafour Software in Cerritos, Calif., and Madras, India, and Hanho Heung-Up Co. Ltd. in Seoul, Korea.

Using Internet and satellite connections, rough animations are sent to Korea, where draw-rags are scanned into Cambridge Animation's Animo DIPS, cleaned up and placed in the XSheet. Digital files are then transferred to Madras, where Pentafour does imaging, inking, painting and basic special effects, including some three-dimensional Alias/Wavefront animation. Finally, files are transferred back to Burbank, where Rich Animation fine-tunes the special effects.

This innovative marriage of digital ink and paint and the Internet - which Cambridge Animation says is a first - isn't the only breaking news from the DIPS front. At the recent SIGGRAPH computer-graphics show, Sony demoed a new PC-based two-dimensional animation system for cartoon animation that features Sony cameras for capturing line drawings, ink and paint, compositing and editing. And other DIPS vendors are offering improvements to existing tools: Cambridge Animation just ported its Animo Ax-Cel software to PC, and French toolmaker MediaPEGS just ported to Windows NT and added a new lip-sync tool.

But an animator looking for technology's bleeding edge doesn't need to look any farther than motion capture, the technique that 'captures' movement data from performers hooked up with magnetic or optical sensors

and uses that to animate three-dimensional computer characters. Once an esoteric art, motion capture (also called performance animation) is getting increasingly user friendly and affordable. One recent example is Johnny Chimes, NBC's new virtual peacock spokesman, which is a serendipitous marriage of Ascension Technology's new wireless motion-capture system and a performer-puppeteer duo from Medialab Studio L.A., the Burbank performance-animation facility. Venice-based Modern Cartoons, which is partnered with Sweden-based Kinnevik, offers its own proprietary real-time animation system, which is seen in the form of co-host Cyber Lucy on the new CBS kids' show 'Wheel 2000' and the recently aired 'Steve Oedekerk.com' special seen on NBC.

Clunky cables hooking the performer to the real-time magnetic system have always been a hindrance, but now Polhemus is offering a wireless Star*Trak system that allows four actors to move freely over a 25-foot-by-25-foot area. And even the nuances of facial expressions are being captured. D 'n A's LIFEsource system is just one of many that enables real-time results with a smile.

Toonsters interested in using motion capture to create two-dimensional cartoons in real time will want to check out Montreal company Kaydara, which after four years of development debuted their brand-new FiLMBOX motion-capture system at last month's SIGGRAPH. With a license for LiveStyles three-dimensional artistic rendering technology from ThinkFish Productions in San Francisco, Kaydara's FiLMBOX can turn three-dimensional models from software packages - such as Softimage 3D - into two-dimensional cartoons in real time.

Kaydara also addresses one of the big obstacles that has prevented motion capture from gaining wider acceptance. Up until now, users have had to write custom code to finesse the captured data enough to animate three-dimensional CG characters. Kaydara's FiLMBOX is a Windows NT or SGI-based software solution that connects data from any motion-capture system to all the major three-dimensional software programs. Lambsoft launched a similar package, Pro Motion NT, which applies captured motion data from magnetic, mechanical or optical motion-capture devices directly onto a character in Kinetix's 3D Studio MAX. With these packages, motion capture is poised to become a more widespread tool for animation studios on a budget.

Among vendors of 3-D animation software, terrific tools are just around the corner. Softimage, which showcased its Toonz for Digital Studio among other tools, is getting closer to its 1998 **release** of Sumatra next-generation architecture. **Alias / Wavefront** , which announced plans for a complete Windows NT implementation, reports that its Maya architecture is in full production at 50 beta sites in anticipation of a first-quarter 1998 release. Kinetix introduced a major new release of its 3D Studio MAX, and Side Effects - which just released Houdini, a procedural animation software tool with a more friendly interface than its popular Prisms - announced it will port the entire Houdini program to Windows NT for a 1998 release.

Though many software manufacturers are migrating to Windows NT, they're far from giving up on versions for SGI and other platforms. Perhaps Electric Image CEO Jay Roth, on the heels of an announcement that his company's software is being rewritten to be plat-formed independently, says it best when he notes, 'We're catering to a graphics community that's become hardware agnostic.' That means that the next generation of tools is almost certain to be available for multiple platforms. And, in light of the news that Microsoft just invested $150 million in Apple, the message is: Don't throw away your Mac just yet.

Artist-centric Mac tools keep on coming on. From newcomer Puffin Designs is Commotion, a cool paint and effects application that allows animators to play back uncompressed resolution-independent video and film sequences in real time on the Macintosh. Another product to watch is Illuminaire, a Mac- and NT-based compositing and paint system from Denim

Software, which was just acquired by Discreet Logic.

On the SGI side, Discreet Logic announced plans to release Flint on Silicon Graphics' new low-cost 02 workstation. And Harlequin's SGI-based PanOptica is a unique postproduction tool that analyzes nodal (tilting, zooming and locked off) camera moves and allows the user to take out or add moving objects, generate clean plates, change the camera motion and even generate the same clip with a new aspect ratio. And desktop animators everywhere will get a big boost from Viewpoint Data Labs, which just merged with ThinkFish Productions and released a brand-new 3-D CD-ROM catalog with - count 'em - 10,000 models.

The message from software manufacturers is: If you've got the talent, we've got the technology. In the world of digital technology, it's never been a better time to be an animator.

... showcased its Toonz for Digital Studio among other tools, is getting closer to its 1998 **release** of Sumatra next-generation architecture. **Alias / Wavefront** , which announced plans for a complete Windows NT implementation, reports that its Maya architecture is...

20/7,K/3 (Item 1 from file: 148)
DIALOG(R)File 148:Gale Group Trade & Industry DB

10211828 SUPPLIER NUMBER: 20396994 (THIS IS THE FULL TEXT)
Say a-h-h-h-h. (new animation software offers custom features and project-specific tools) (Technology Information)
Robertson, Barbara
Computer Graphics World, v21, n3, p28(7)
March, 1998

TEXT:

A new generation of animation software based on an open, procedural architecture paves the way for technical directors and nontechnical animators to craft custom features and project-specific tools

Commercial 3D animation software has undergone a fundamental change in the past two years. The transition began with the introduction of two programs: 3D Studio MAX by the Kinetix division of Autodesk and Houdini by Side Effects Software Inc. Last month, Alias/Wavefront joined the revolution and pushed it forward with the introduction of **Maya** . Nichimen is expected to follow suit in August with the **release** of Dune, its next-generation product. And Softimage has scheduled Sumatra, its entry in the race for the fourth quarter. Further in the future, Newtek hints at project Purple, which will be its new version of Lightwave, and Electric Image is now talking about a new architecture for a future generation of its promised program with modeling, animation, and rendering capabilities. People are getting excited.

"When we first started making images on computers, they had little impact, but you could project what would happen, and it's clearly happened," says Richard Hollander, president and visual effects supervisor at BlueSky/VIFX (Santa Monica), who received a technical Academy Award this year. "Jurassic Park, Starship Troopers, and Titanic are the culmination of that. But we're on another precipice right now. We're poised for another blast that will be equal in impact to using the computer to generate images in the first place."

Maya. Houdini. MAX. Sumatra. Dune. This new breed of programs aimed at helping animators scale new heights replaces products with colder, more technical names: Power Animator, Advanced Visualizer, Prisms, 3D Studio, Softimage 3D, N-World. And yet, pail of their importance is the freedom

they give technical directors and CG supervisors as well as artists and animators.

All these programs offer sophisticated modeling, animation, and rendering capabilities, but what makes the software qualify as part of the next generation is not the feature set, it's the underlying architecture. They're all based on an "open" and extensible architecture, they all have a procedural architecture, and they all offer a scripting language or the equivalent. In this generation of software, animators can customize programs with nearly as much flexibility as a programmer without ever writing code; and programmers have the tools to write plug-ins that extend the basic toolsets. "I think the trend now is to improve the architecture, not just add features," says Gary Yost of the Yost Group, 3D Studio developers. "I think its making this business a lot more interesting."

"You can go to half a dozen Websites and get hundreds of free plugs-ins for MAX now," says George Maestri, an Los Angeles-based animator who was most recently producer of the popular animated TV show, South Park. "A lot of the plug-ins are goofy, but some are really good."

"Everyone is moving their software toward openness," says Edward Kummer, vice-president of digital operations at Digital Domain, a visual effects studio in Venice, Calif. "You've got to be able to change things."

"This is so significant," says Hollander. "Maya and Houdini allow us to go in and add our solutions within their working environments, and Sumatra probably will. As time goes on, this will become the norm."

"Six years ago, software was and hackable, and you didn't hit a ceiling" says Mark Wendell, CG supervisor at Santa Barbara Studios. "Then everyone got enamored with GUIs (graphical user interfaces), and we started hitting ceilings."

The GUIs gave non-technical animators easy access to tools, thus providing a much-needed path to computer animation for people who would otherwise have avoided the machines. Unfortunately, the pretty interfaces made customization difficult for technical directors (TDs).

Autodesk took the lead in showing companies targeting the entertainment industry why it made sense to have third-party developers add functionality--a strategy that Yost had implemented in software he developed for the Atari in 1986 and that Autodesk had also successfully leveraged with its AutoCAD software. Eventually, other software companies including Softimage, Alias, Lightwave, and Electric Image also began offering software development toolkits (SDKs) so that programmers could write "plug-ins" to extend the toolsets packaged within the fancy GUIs, and studios used the SDKs to extend functionality as well.

The problem is that to create a plug-in for most programs, someone has to write C++ code. That's fine for third-party software developers. It's not so fine for production studios working on fast-track projects. Yet, like people in most studios, Wendell. believes they must be able to customize and extend software for particular projects to have a creative edge. At the same time, they need to have software that nontechnical animators can use.

"We had character animators who wouldn't join the company unless they could use Softimage 3D, but the TDs were faced with closed, monolithic software," Wendell says. "So we had to have full-time programmers who did nothing but extend the Softimage toolset."

Two 3D animation software programs, however, followed a separate route. Side Effects! Prisms had a procedural architecture that gave technical directors enormous flexibility, but the lack of a GUI made it hard for many animators to use. Similarly, the pioneering LISP-based Symbolics software, which was being ported to Silicon Graphics hardware as it moved from Symbolics to Triple-I and finally to Nichimen, had a wide-open, object-oriented architecture but lacked a pretty interface.

The next generation of 3D animation software began when the PC-based 3D Studio evolved into the Windows 95 and NT-based, object-oriented MAX; and SGI-based Prisms evolved into easier-to-use Houdini, which now also

runs on Windows NT.

3D Studio's WAS routines had allowed third-party developers to build plug-ins, and hundreds did, but this software could not be incorporated into the user interface and was therefore somewhat cumbersome for users. With MAX, the plug-in developers could add features that would became a seamless part of the user interface. Now, some of the most interesting features in MAX for deformation, lattices, and character animation have been created by third-party developers. This development is enthusiastically encouraged by Kinetix. "Our goal has always been to have the largest programming team in the world," says Yost.

Side Effects already had an open, procedural 3D animation program with Prisms. For its second generation, the company integrated its 2D and particle/effects software into Prisms, gave the new program a visual interface, and named it Houdini. The result is perhaps the richest, seamless integration of 2D and 3D animation, effects, audio, and compositing software within a single open environment on the market.

MAX R2, which runs under Windows NT and 95 on Intel platforms is priced at $3,495, and is aimed at a wide market. Houdini, which runs on SGI machines and under Windows NT, is priced at $15,000 and serves the high-end.

During the past year, Side Effects created additional modules for Houdini that let people work procedurally with motion and audio (CHOPS), particles (POPS), and textures (TOPS) as well as with geometry and 2D tools. Using the visual interface for Houdini's procedural network, people can now connect the output from a motion operation to the input of an audio operation and connect those to a particle operation and connect that to something else--in effect, writing scripts.

So far, only a few people have been able to work with the Houdini's new particle operators (POPS), which are scheduled to ship with Houdini 2.5 in March. Paul Salvini, director of production development is one. "The surface modeling tools take on new power because the modeling operations can be animated, and we can combine intersecting, multiple surfaces with POPS," he says. "This means we can model a ship, animate it crashing through waves, and have particles that automatically change color bursting from the intersections of the hull and the waves."

Clearly, Alias/Wavefront has learned from these competitors. In fact some people describe Maya as a hybrid--with a procedural network similar in concept to Houdini's architecture, but with a friendlier user interface, a scripting language (MEL), and a C++ SDK. Alias/Wavefront integrated the software they inherited from TDI (Explorer) and from their own companies, added features, solidified its reputation of having the best modeling tools, and by all accounts has created a very fast, interactive software program with good character-animation tools and a good renderer.

Like Houdini, Maya is available on SGI machines with an NT version to follow. Although Maya does not integrate 2D functions as does Houdini, adding this capability is high on the "To Do" list. "We have the user interface, MEL, and the 3D building blocks. Now one of our highest priorities is to get imaging, painting, compositing, and an audio subsystem into Maya," says Thin Williams, chief technical officer at Alias/Wavefront. "Now that we have an architecture we can build on, we can also focus on specific interfaces for small domains--to do matchmoving; for example."

"Quite honestly, Maya doesn't have too many features you can't see in other packages," says Maestri. "The modeling is unequaled, the set-driven keys are very innovative, and the rendering pretty incredible, but other packages have similar features. MEL is good, but other programs have scripts, too. However, the architecture is very good. You can set up networks like you can with Houdini, but with Maya, you can do this while you work as usual. Maya will build the connections behind the curtain."

"I just hope Alias/Wavefront revisits Maya's pricing structure," says Maestri. Maya is priced at $10,000; additional modules cost $5,000 to $10,000. "With MAX, some things I need cost extra as plug-ins, but 20 grand

will buy a lot of plug-ins." But Hollander, though impressed with MAX R2, believes high-end programs, such as Maya, Houdini, and probably Sumatra, have nuances that make them valuable.

The architectures of MAX R2, Maya, and Houdini are not identical, however. Unlike Maya and Houdini, MAX R2 has a procedural stack architecture rather than a procedural network. Houdini and Maya allow any block to be tied to any other. A stack architecture works in a more top-down manner, although in MAX R2 this isn't strictly the case, and the scripting language gives animators additional flexibility. "It needs better documentation, but I've been able to script motion controllers with it," Maestri says of MAX R2's scripting language. "Every plug-in, every function is available as a script You can write your own interfaces."

"These toolsets are powerful," says Hollander. "I can define user interfaces for particular projects. We can make creature animation that's far more intuitive, provide lighting tools for people who aren't software experts. They are big, big news items and they're starting the revolution."

At Kleiser-Walczak, people are using Maya to create a 70mm ride film, for Universal Studios. "Our entire workflow has shifted to Maya because we've found tools we've been unable to get in other packages," says Derald Hunt senior animator. "We can create custom control panels and hand them off to animators who only have traditional animation experience, and they fly."

Also excited about Maya is Loren Olson, technical director of Rhonda Graphics (Phoenix, AZ), a 10-year-old digital studio known particularly for its broadcast work. "We've been beta testing the software for more than a year and a half," he says. "We were concerned that when they integrated the Alias and Wavefront programs with all those aspects, kinematics, dynamics, particles, and added the embedded language, it would be a dog. But it's the fastest system we have. We're in production with it now."

Olson is particularly impressed with MEL, the scripting language. "You don't have to know MEL or even that it exists but everything you do interactively can be done with a MEL command, and it's a language so there's flow control," he says. "For example, I can find attributes and automatically change them on thousands of objects using a MEL procedure."

Wendell thinks that character animators at Santa Barbara Studios will be hard pressed to move from Softimage onto Maya, at least at first "Maya has a brilliant architecture and a rich set of low-level tools, but they need to add the high level controls that are rich in Softimage-like enveloping tools." He points out that Maya has a different philosophy, though, one that makes it easy for TDs to create controls for characters so animators can puppet them like marionettes.

Maestri thinks character animators won't have trouble moving to Maya. "I think a lot of people may switch to Maya because the character animation is quite good," he says. "I think Maya will be the feature film package. Softimage will keep a niche in character animation, but Sumatra better be one incredible package."

Like Houdini, Sumatra will be based on operators, with "everything in the system a separate function that can be applied to another function and all will relate," according to Dan Krause, 3D products manager at Softimage. And like Maya and MAX R2, it will have a scripting language. (With Houdini, people create "scripts" by connecting boxes and writing expressions.) The thing that will distinguish Sumatra from Houdini, MAX R2, and Maya, he believes, will be the animation.

"We're applying some of the things we've learned from performance animation to production," Krause says. "Sumatra has the notion of nonlinear animation." He explains that different parts of an animation could be mixed together by an animator using sliders. For example, one slider might control a punch and another might control body movement. Sumatra would automatically interpolate in between as an animator works the actions against each other.

The biggest problem with Sumatra is that it won't be released until

the fourth quarter of 1998. By then, Maya may have already had an upgrade, and Kinetix and Side Effects should be close to releasing the third versions of MAX and Houdini, Krause says Softimage's rendering program Twister will have the same interface as Sumatra, but it's not scheduled until the third quarter. In the meantime, Softimage plans another release of Softimage 3D and promises that all the plug-ins written for will work with Sumatra.

Also concentrating on making motion easier for animators is Nichimen. "Software companies need to apply the object-oriented architecture they have for modeling and editing to motion," says Maestri, "so that animators can edit motion above the keyframe level just as they can edit models above a vertex level. Houdini's CHOPs is good, but it takes what I call the inside out approach by giving animators tools to build an interface. Nichimen's new N-Motion comes close because it lets animators edit motion like they edit video on an Avid."

Nichimen's Dune will take that notion one step farther by integrating N-Motion with the full suite of Nichimen 3D and 2D modeling, animation, rendering, painting, and effects tools and by providing a new user interface. Based on Symbolics' software, Nichimen's N-World, remains the most open. "We'll embed motion into objects not explicitly with respect to time or space," promises Pinakin Katabamna, marketing manager. "It also will have a remarkable particle system." Nichimen plans to announce Dune in March or April, and to release it in August

"Nichimen's software is going head to head with MAX in games, and the new software could totally dominate the games business," says Maestri. "Because of Nichimen's object-oriented tools, its market could expand beyond games, but unless it can prove its surfaces (the tools for smoothing polygons), it may be stigmatized because it doesn't offer NURBs."

"But I've gone back to polygons," Maestri adds. "I'm creating all my characters for a pilot with polygons, then smoothing the surfaces after I animate." Maestri is mostly using MAX R2 for the pilot of an animated television show. He believes it will be the software of choice for the budget-conscious broadcast world. "MAX is object oriented and has a long list of features," Maestri says. "It's 90% of the way there. The NURBs need another iteration, but for the price, its incredible."

"We're doing all our projects with Maya," says Olson, "but I like the price of MAX and especially that you can buy one copy of MAX and render on all computers. When I think of value," Olson says, "I think of Lightwave and MAX."

Regarding Lightwave, it has ardent supporters. Some of the most fervent have worked together as a group starting at Amblin, where they created 3D effects for SeaQuest, and then continuing on at Digital Domain they used Lightwave for the well-known Andrei Agassi commercial and created a 2.3 million polygon model of the Titanic, parts of which were used in the movie.

Except for Hash, a much-loved character animation program, Lightwave, costing around $1,000, is the least expensive 3D animation and effects package. It also runs on more platforms than any other, having recently added Sun to a list that includes NT, Mac, DEC Alpha, and SGI workstations.

Will that be enough to stave off the competition until they can revamp the architecture? Maestri isn't convinced. "It's not object oriented," he says. "They're still stuck in the old mode, and a lot of things are just hard to do. Some of the plug-ins are separate programs. You have to run them, do your animation, export the data, and reload Lightwave.

Newtek's Brad Peebler would rather talk about this generation of Lightwave. He attributes the success of Lightwave in broadcast particularly to time they've spent dealing with production issues. Lightwave has an open-file format that makes it easy to transport data, and a production-tested design. "We've streamlined the interface, the render engine is one of the best, and the price point is lower by half than any other comparable software," he says.

Also popular in broadcast is Electric Image, however, the promised modeling component has not yet shipped, nor has the version for NT. Although considerably more expensive than Lightwave, Electric Image also has loyal supporters. Matt Hoffman, director of product development, says that in addition to being used for broadcast, a major film studio is using the Macintosh-based animation and rendering software to previsualize an upcoming science-fiction movie. The company also plans to create a new architecture that will open the software, which now only offers people an SDK for creating plug-ins. "Our software has not been very open," says Hoffman. "But we're moving toward what Houdini can do--to give people access to the core data so they can create any interface they want."

"If you want to cut the cost of production, you have to get closer to the tools," says Paul Osepa, who recently co-founded X07, a new animation studio in Brentwood, Calif., with Matt Elson. Both are long-time users of procedural software such as Nichimen. "In any given project you'll eventually hit a bottleneck. With object-oriented, procedural software the parts don't just do one stupid thing. They can be reconfigured, rewired, rearchitected visually. You don't want to keep starting over."

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... Last month, Alias/Wavefront joined the revolution and pushed it forward with the introduction of **Maya** . Nichimen is expected to follow suit in August with the **release** of Dune, its next-generation product. And Softimage has scheduled Sumatra, its entry in the...

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REPORT ON SIGGRAPH 97

Computer Aided Design Report, v17, n9, pN/A
Sept 1, 1997

TEXT:

WINDOWS NT STEALS THE SHOW

There's a new world order in graphical computing. For the last couple of years, companies that market computers and software running Windows NT have been knocking on the gates of visual computerdom. Now these NT upstarts are running the show.

That much was apparent at last month's Siggraph 97 trade show. Siggraph is an annual gathering of anybody who has or wants a stake in such high-performance graphics fields as Hollywood animation, computer games, satellite imaging, map making, virtual reality, scientific visualization, three-D CAD, product styling, Web viewer software, or broadcast video. Although CAD applications are not showcased at Siggraph, the show remains the premiere place to find out about specialized graphics hardware needed to accelerate the most powerful CAD software.

For years, Silicon Graphics Incorporated was the star of Siggraph. Even in 1996, Siggraph remained in many ways SGI's show. But this year,

systems based on Windows NT as opposed to SGI's Unix stole the limelight.

SGI still had a large Siggraph presence. It bought more floor space than it did two years ago, the last time Siggraph was in LA. This year SGI's booth was again the single largest one. The display of real estate wasn't enough, however, to move SGI out of the Wintel shadow. In terms of total area, the combined size of the booths of Intel and Microsoft and its SoftImage subsidiary just about matched the 12,100 square feet leased by SGI for itself and Alias/Wavefront, according to data supplied by the Siggraph conference managers. More importantly, software running on Intel-based computers with Windows NT were just about everywhere else on the exhibit floor.

Even SGI found itself feeding the perception of NT's hegemony. SGI's Alias/Wavefront subsidiary announced development plans for a Windows NT version of its three-D **animation** product called **Maya** . SGI also distributed a press **release** from Autodesk's Kinetix subsidiary announcing that its new 3D Studio MAX R2 will support Microsoft's precision-based implementation of OpenGL, the graphics library invented by SGI, but incorporated into Windows NT by Microsoft. In the same press release, Kinetix also announced support for Microsoft's Direct3D, a competitor of OpenGL. (See the Graphics API Wars in the June 1997 CAD Report for more discussion.)

Keeping a Grip

While SGI spokespeople talked candidly about the NT challenge, they seemed frustrated by the perception that somehow the company is reeling. They were quick to point out that SGI has just run up its first billion-dollar sales quarter, with revenues in the April through June 1997 period up 16 percent compared to the same quarter in 1996. And at Siggraph 97, there was ample evidence that at least at the very top end, SGI still remains firmly entrenched.

In the Silicon Garden, an area set aside at Siggraph for the computer industry's cutting edge developers to show off the latest wares to the elite (entrance was restricted), SGI workstations remained the dominant platforms. There, a couple of computer technicians from NASA's Jet Propulsion Laboratory confided that despite claims by SGI's Unix competitors, it was SGI computers that have been doing the heavy lifting of constructing images from the data beamed to earth by the Mars Pathfinder. That said, the inescapable conclusion left from wandering the exhibit hall is that SGI has been forced to share many, possibly most, of the niches it created in graphical computing with a growing flock of Wintel rivals.

Hard News

Most of the important news generated at the show turned on the Windows NT onslaught or SGI's response to it. Following are some of the highlights:

* SGI on Intel? SGI confirmed in part some of the rumors raging around the show that it is contemplating the unthinkable: developing a Windows NT platform using Intel microprocessors.

* SGI price cuts. SGI cut the price of its top workstation-class machine, the Octane, and offered a bargain-basement special for its entry-level O2. Both systems have been going head-to-head with a growing spate of Windows NT workstations equipped with hot, new graphics plug-ins.

* NT against Onyx2? Some of the most ominous news for SGI came in the form of promises from HP and Intergraph that before the year is out they will introduce Pentium II workstations that will match the performance of SGI's Onyx2 class of graphics supercomputers. While these announcements could be dismissed as posturing, the bluster also reflects the reality that the NT sea change now threatens even the top end of graphical computing.

* Mighty Intergraph. The Huntsville firm was responsible for some of the meatiest of announcements at Siggraph 97, including the introduction of its second generation of Pentium II graphics workstations. The TDZ 2000 computers and the new RealiZm II graphics adapters that go with them allow Intergraph to lay its strongest claim yet to better-than-SGI performance.

* Mail-order mania. In yet another indication of how much things have

changed, mail-order computer companies Dell and Gateway 2000 proclaimed they are serious about offering SGI-like performance on computers sold like PCs.

* New OpenGL adapters. Finally, there was a spate of news from vendors of those three-D accelerator cards that so many computer vendors like to resell.

SGI on Intel?

While the rumors spoke of an imminent announcement of an Intel-based product from SGI, a company spokesperson said that nothing will be announced immediately. In a post-Siggraph interview, the spokesperson did say, however, that an internal review is focusing serious attention on how SGI can respond to the growing presence of Windows NT workstations in three-D CAD, video-content authoring, games development, and other graphical niches.

(SGI Chairman Ed) McCracken said the goal is to become the leading supplier of technical workstations, said Steve Proffitt, marketing manager for the O2 line. In order to do that, we may have to lose the religion on Unix. The stumbling-block is we need to do something that's different. It will not do for SGI to come out with a me-too product.

SGI's posture represents a major role reversal. Two years ago, then-CEO Tom Jermoluk said SGI would never produce what he called dumbed-down, personal-computer type technology, a reference to NT on Intel. If the violin were user-friendly, it would not be a violin, Jermoluk told a crowd of journalists at a Siggraph 95 press conference. Since then, Jermoluk has departed the company. McCracken and executive vice president Gary Lauer together have been saddled with the task of regaining momentum while the Unix workstation market has experienced flat growth, in large measure because NT workstations have exploded into most of SGI's former strongholds.

Proffitt declined to say what specific products the company was considering developing for NT. With Microsoft having given up its support for NT on SGI's home-grown MIPS microprocessor architecture last year (see the November 1996 CAD Report), any NT-based workstations would likely have to use Intel products, Proffitt said.

While SGI may feel pressure to move quickly to prevent erosion in its visual-computing niches, developing any product on a microprocessor architecture new to SGI would take time. Another problem SGI would face if it brings to market an Intel-based platform would be maintaining the loyalty of the company's installed base of customers with computers that, like Octane and O2, are based on MIPS microprocessors. SGI is not planning to abandon the MIPS architecture, Proffitt said.

SGI Price Cuts

In response to the NT onslaught, SGI's main hardware announcements at Siggraph involved price cuts in its workstation lines. For a Siggraph show special SGI marked down to $4,995 an entry-level O2 computer with a list price of $8,495. The company claimed that nearly 1,000 buyers were attracted by the deal. After the show, the price rebounded to $7,495.

SGI also slashed prices of the more powerful Octane line of computers by $5,000. Versions built around an R10000 microprocessor now start at $19,995 for an Octane SSI with 64 megabytes of main memory, a two-gigabyte hard drive, and a 21-inch color monitor. The uniprocessor line tops out with the OctaneMXI costing $55,495 with 256 megabytes of main memory and a four-gigabyte hard drive. Dual processing versions start at $28,495. Contact: Silicon Graphics Incorporated, 2171 Landis Drive, Mountain View, California 94043 Telephone: (650) 960-1980 FAX: (650) 961-0595 Web site: http://www.sgi.com.

Vectras Against Onyx2?

For its OpenGL graphics adapters in its NT-line of VectraXW and XU workstations, Hewlett-Packard has relied on third-party manufacturers AccelGraphics and Mitsubishi's VSIS subsidiary. At the same time, the company's powerful homemade Visualize graphics hardware developed for its

PA-RISC, Unix workstations have not been OpenGL-friendly.

This oversight is about to change. HP says it soon will offer a new version of its Visualize graphics technology for Pentium II workstations. Due to be introduced next month, the adapters will accelerate calls to the OpenGL programming interface used by most three-D CAD programs.

HP claimed the new graphics will deliver a score above 100 on the OpenGL benchmark based on Parametric Technology's CDRS modeling and rendering software. That compares to a score of 92.72 for an SGI Onyx2 Reality computer with two 195-megahertz MIPS R10000 microprocessors. Such an Onyx2 system lists for around $125,000. HP product marketing manager Dave Dupont said the cost for the new Pentium II product will be well under $20,000.

While HP's public statements were vague, a lot more could be learned by talking with people at HP's booth. One fellow told us the accelerators for the new systems will contain either one or two geometry engines based on PA-RISC 8000 floating-point units, making HP the second vendor after Intergraph to offer geometry acceleration in the Windows NT space. Geometry accelerators perform floating-point calculations for the system central processor. (See the September 1996 CAD Report for more about geometry acceleration.)

A sign above one of the Pentium II prototypes was titled Intel AGP Technical Demo, indicating that the adapters will plug into Intel's new graphics port. Intel has developed AGP in part to prevent the PCI bus from becoming a graphics bottleneck and also to allow main memory to be used to store texture data, something to promote three-D graphics applications for cost-conscious, nontechnical users.

The sign also said that the product would be capable of drawing more than 3.4 million smooth-shaded triangles to the screen. That compares to two million for the VSIS 3dpro/2mp, which currently boasts the fastest triangle-drawing rates of any NT accelerator on Intel computers.

But people who want to visualize very large designs, such as whole automobiles, bulldozers, or big industrial machines, may find that HP's new Vectras are not the equal of top-of-the-line Onyx systems after all. The sign in HP's booth promised a score of 6.9 on the benchmark based on Intergraph's DesignReview plant layout and visualization program, which does a better job of testing how well a computer moves data between the CPU and main memory than does the CDRS Viewperf. This DesignReview score is far lower than the 16.27 of SGI's Onyx2 machine.

INTERGRAPH'S TDZ 2000

Not to be outdone, Intergraph also claims it will breach the century mark on the CDRS Viewset before the year is out, but the company declined to provide details. The real products Intergraph had to announce at Siggraph were its second generation of Pentium II computers that top out its TDZ family of three-D workstations. These systems have redesigned graphics accelerators and motherboards.

Like the first generation of RealiZm adapters, the new accelerators support high-resolution, true-color images. Depth information in scenes is rendered from 24 bits to 32 bits of accuracy. Also, like the earlier adapters, the RealiZm II accelerators are differentiated by the sizes of their display buffers. Their names are, in part, derived from the maximum resolutions they can support.

- The ZX13 has 16 megabytes of display memory, enough to support three-D resolutions of up to 1,280 by 1,024 pixels, or about 1.3 million pixels total.
- The ZX25 and VX25 each come with 32 megabytes of display memory, enough for three-D, true-color resolutions of up to 1,824 by 1,368 pixels, or nearly 2.5 million total pixels.
- The VX25 also comes with additional digital signal processors, which do much of the work of processing image data on the RealiZm adapters. As a result, they are somewhat faster than the ZX25. Also, the VX25 is available only with dual-processor systems.

Each RealiZm II card can also be equipped with four, 16, 32, or 64 megabytes of memory for texture maps, which are canned images that can be applied on the fly to surfaces of a moving model. RealiZm II texture buffers are controlled by circuitry that will apply surface materials using the highly accurate trilinear filtering technique (described in the October 1996 CAD Report).

Like previous RealiZm cards, Intergraph's new models plug into the PCI bus, not the faster AGP bus that also can be found on the workstation's motherboard. Steve Pesto, executive director of Intergraph's workstation division, says his company is not planning to deploy AGP cards any time soon because the PCI bus is adequate for today's graphics workloads. Pesto says the AGP slot was built into the TDZ 2000s, so that they can be upgraded with AGP adapters when they become available.

Lynx 3 Geometry Accelerators

Intergraph has upgraded the RealiZm geometry accelerators, which are a $3,495 extra cost option. What's new in the RealiZm II geometry accelerators, code-named Lynx 3, is a four-megabyte memory buffer that functions like a staging ground for the graphics subsystem. This geometry buffer receives data sent out from a special burst buffer, built into the Pentium II microprocessor, Pesto says. He claims this DirectBurst technology means image data need not be loaded into microprocessor caches, which thereby reduces traffic on the PCI bus. The end result, says Pesto, is faster graphics and better overall performance because caches and bus cycles are freed for other uses, while the image data gets delivered to the graphics adapters more quickly.

Faster Main Memory

All TDZ 2000 computers will come with either one or two Pentium II microprocessors, clocked at 300 megahertz. The microprocessors are supported by Intel's new 440LX chip set, which orchestrates the work of the PCI bus. The 440LX is an improvement over the 440FX, the chip set found in most of today's Pentium II computers. It permits main memory banks to be filled with synchronous DRAM chips, which operate more quickly than the EDO memory chips that work with the 440FX.

The combination of SDRAMs and the 440LX chips allows the Intel systems to benefit from what is called X-1-1-1 timing. That means once data starts streaming into CPU caches from main memory it takes only one memory bus clock cycle to bring in additional pieces of data. Many NT-class machines, including some first-generation TDZs, do not enjoy this capability, which can bring better performance for users working on very large data sets. Another way to achieve X-1-1-1 timing is to use memory interleaving, a strategy deployed by Compaq in its Professional workstation line. But interleaving requires that all memory banks in a system be filled, and achieves X-1-1-1 timing only when the data that needs to be retrieved is stored in consecutive memory locations.

High-Speed Disks

Intergraph is also delivering faster disk drives in the TDZ 2000 workstations. The new drives have spindle speeds of 10,000 rotations per minute, compared to 7,200 and 5,400, today's standards. The speedier drives are more costly but provide faster access to data. The biggest benefit of this for typical technical users will be shorter waits while applications, models, scenes, and assemblies load.

Stylish Packaging

Intergraph's TDZ systems are housed in a new Ultra-tower Chassis with a contoured, bluish-purple case reminiscent of SGI's Origin, Onyx2, Octane, and O2 computers. The Ultra-tower comes with six full-sized PCI slots and one shared PCI/ISA expansion slot. Ultra-Wide SCSI and 10base/100Tx adapters are integrated into the motherboard, so they don't occupy expansion slots. The Ultra-tower also comes with three 3.5-inch by one-inch bays or two 3.5-inch by 1.6-inch bays for storage peripherals. Four-gigabyte and smaller disk drives use 3.5-inch by one-inch bays, while the larger bays are needed for nine-gigabyte drives.

Another innovative feature of Intergraph's Ultra-tower is the optional TowerMate Expansion Base. When attached to the base, the Ultra-tower gains six additional PCI expansion slots and up to five extra bays for storage peripherals. This additional capacity enables a TDZ 2000 computer to play the role of a small-group file server with up to 63.2 gigabytes of total disk storage.

Performance

Intergraph stakes its claim to superior performance of the TDZ 2000 workstations in large measure on the machine's OpenGL Viewperf results, most notably an impressive 65.79 composite score on the popular CDRS benchmark (see the accompanying table). That compares to 48.63 for SGI's top workstation, the OctaneMXI. On other OpenGL benchmarks, the top TDZ 2000, a dual Pentium II with RealiZm VX25 graphics, and the OctaneMXI seem evenly matched.

On CPU benchmarks, the Intel-based TDZ 2000 has substantially better integer math performance, as measured by the SPECint base95 suite, while the Octane, based on the MIPIS R10000 running at 195 megahertz, is a better machine for floating-point math.

Generally, integer math is more critical, so the balance tilts toward the TDZ. On the other hand, a lot of high-end graphics and other technical applications have long been tweaked for SGI platforms, so benchmark results don't give the full picture. In addition, Octane's other advantages are its superior internal bandwidth, so it will be better for applications that require moving vast amounts of data.

Pricing and Delivery

Even if an OctaneMXI remains somewhat faster, Intergraph's TDZ 2000 computers cost about half the price. The TDZ 2000 3D Graphics Workstations start at $11,495 with 64 megabytes of main memory, a four-gigabyte, 10,000-RPM hard drive, and a RealiZm ZX13 adapter. Extra main memory costs $10 a megabyte. Customized texture memory costs between $111 per megabyte for four megabytes and $78 per megabyte for a 64-megabyte module. The best 21-inch monitor Intergraph is selling costs $2,195, but a cheaper monitor, with lower refresh rates, can be had for $1,695.

The TDZ 2000 computers are due to ship in October. The expansion base, however, is not due out until December. No price has been set for the base yet. Contact: Intergraph Computer Systems, U.S. Headquarters, Huntsville, Alabama 35894-0001 Telephone: (800) 763-0242 or (205) 730-5441 FAX: (205) 730-6445 Web site: http://www.intergraph.com.

DELL AND GATEWAY ARRIVE

Competition from Intergraph and Hewlett-Packard should give Silicon Graphics executives cause for concern, but the entry of Dell and Gateway 2000 into the workstation market might well give them ulcers. As of Siggraph 97, both mail-order companies are claiming to deliver workstations with graphics that compete favorably with the low end of SGI's line.

Dell announced that it will resell three-D adapters based on 3Dlabs new Glint MX rasterizing chip (see below) and the Delta setup chip. The adapters are assembled by Elsa, Inc., the U.S. subsidiary of a German-based firm. Dell's new Workstation 400M computers come equipped with one or two Pentium II CPUs clocked at either 266 megahertz or 300 megahertz. A computer at the top of Dell's 400M line costs $7,079, including a 300-megahertz Pentium II, the Elsa Gloria-L/MX graphics adapter, 128 megabytes of main memory, a four-gigabyte hard drive, and a 20-inch color monitor. A second 300-megahertz processor adds $1,199 to the cost.

We're fond of Dell computers. In fact, most of the machines we now own are made by Dell. However, we have had trouble with software drivers for some of Dell's Number 9 adapters, and Elsa, the company that is making Dell's three-D cards, also has had problems with its software drivers. (See page 15 of the January 1997 CAD Report for details.) For these reasons, we don't want to be the first on our block to buy one of Dell's new three-D systems.

The best way to contact Dell is via the Internet's World Wide Web. At

Dell's Web site, you can configure various systems to see what they will cost. Dell's Web site address is http://www.dell.com. Dell's address is One Dell Way, Round Rock, Texas 78862 Telephone: (800) 408-3355 FAX: (512) 728-8237.

Gateway 2000 also announced that it will start marketing Windows NT 3D workstations before the year is out. A company executive said that Gateway will resell a future generation of AccelGraphics adapters.

OPENGL ADAPTERS

There were plenty of announcements from makers of the graphics accelerators, key elements in making the three-D market on Windows NT platforms viable. 3Dlabs is shipping a few new chip sets, including two that will surely be popular among cost-sensitive mechanical CAD engineers. The San Jose firm has introduced the Permedia 2 consolidating onto one chip, the Permedia rasterizer and Delta setup engine that used to take up two chips on the original Permedia NT boards (see the January 1997 CAD Report). But Permedia 2 is still not the right chip for professional engineering applications because it can only support screen resolutions of 1,024 by 768 pixels when rendering three-D images interactively.

Of more interest to us are the improvements 3Dlabs is making to its higher-end line of Glint-based products, which have a more complete feature set than Permedia. The company is phasing out the Glint 500TX in lieu of an upgraded version called the 500TX Gold. The new chip has smaller feature sizes and faster internal clocks. It is also a bit cheaper on the average. Board-level products based on it cost about $900.

At the top end, boards based on 3Dlabs's new GlintMX are starting to take over the mainstream of the company's product line. The MX contains circuitry to achieve trilinear filtering for applying texture maps, while the 500TX was limited to less accurate bilinear methods. The MX is at the heart of the Ultrafx from NeTpower (see the June 1997 CAD Report).

3Dlabs markets its products through a number of vendors who actually fabricate the board. Permedia 2 products are being sold by Diamond Multimedia, Elsa, Inc., Leadtek, Omnicomp, and Symmetric. Elsa and Leadtek are marketing Glint 500TX Gold boards. AccelGraphics, Elsa, NeTpower (which offers the boards as part of the workstation systems it sells), Omnicomp, and Symmetric are marketing Glint MX-based adapters. The contact information is as follows:

AccelGraphics, Inc., 1873 Barber Lane, Milpitas, California 96035 Telephone: (800) 444-5699 or (408) 546-2100 FAX: (408) 321-0268 Web site: http://www.accelgraphics.com

Diamond Multimedia, 2880 Junction Avenue, San Jose, California 95134 Telephone: (408) 325-7000 FAX: (408) 325-7070 http://www.diamond.com

Elsa, Inc., 2231 Calle de Luna, Santa Clara, California 95054 Telephone: (800) 272-3572 or (408) 919-9100 FAX: (408) 919-9120 Web site: http://www.elsa.com

Leadtek Research, Inc., 46721 Fremont Boulevard, Fremont, California 94538 Telephone: (510) 490-8076 FAX: (510) 490-7759 Web site: http://www.leadtek.com

Omnicomp, 1734 W. Sam Houston Parkway North, Houston, Texas 77043 Telephone: (713) 464-2990 FAX: (713) 827-7540 Web site: http://www.omnicomp.com

Symmetric, 16990 Dallas Parkway, Suite 108, Dallas Texas 75248 Telephone: (972) 931-5999 FAX: (972) 931-7028 Web site: http://www.symmetric.com

Real 3D

Real 3D, a Lockheed Martin subsidiary, plans to offer its own graphics accelerator, called the Lightning/110. Able to draw 750,000 three-D triangles per second, the Real 3D Lightning/110 will compete with products built around 3Dlabs's Glint 500TX-Delta chip set. Its triangle rate will be slower than the accelerator built around the Glint MX-Delta chip set. A Real 3D spokesperson says the Lightning 100 will match the newer Glint MX's ability to fill textured pixels in a scene.

The Lightning/110 contains two three-D graphics chips, a setup processor and a drawing engine. It also comes with 24 megabytes of total graphics memory, including eight megabytes dedicated for texture maps.

Parent company Lockheed Martin has long been a player in the high end of computer graphics, holding a niche in military battle and flight simulation. A company spokesperson said Lockheed first got its start in this market with the U.S. space program, training astronauts to dock Apollo command modules with the lunar lander. In 1991, the company branched out, selling its Model 2 (and later the Model 3) graphics subsystem, which brought polygon-based texture mapping and geometry acceleration into the arcade game industry.

Last year, Lockheed Martin founded Real 3D to target workstation and commodity PC markets. In the early spring, it introduced the Real 3D/100 chip, which sold mostly in visual simulation markets. Then in May 1996, Real 3D announced its partnership with Intel and Chips & Technologies, Inc. of San Jose, California, to develop a consumer-based three-D accelerator for PCs. The chip, now dubbed the Intel 970, is due out later this year. Real 3D is designing the three-D accelerator for the i970. Chips & Technologies (which Intel is currently buying) is designing the two-D chip, while Intel, Real 3D, and Chips & Technologies are working on the circuitry for handling video streams. The Lightening/110 is a different chip than the i970, a spokesperson said.

Real 3D is currently developing a sales and distribution channel for the Lightning/110, with the main target original equipment manufacturers who assemble computer systems sold to end users. Volume shipments are expected shortly after October 1, with the Lightning/110 expected to have a street price of $1,995. For more information, you can check out Real 3D's Web site at: http://www.real3d.com.

Intergraph Intense 3D

Intergraph has introduced the Intense 3D Pro 2200, a new and improved version of a family of adapters unveiled last summer. The main advantage of the new generation card is that it has been re-engineered to eliminate features that led to blank screens on too many computers. (See the June 1996 CAD Report for a detailed discussion of Pro 1000 troubles.)

The new adapter is also somewhat faster than the older version, particularly when applying texture maps. Finally, because of a lack of interest from consumers, Intergraph is not selling geometry accelerators to go with the card. Customers who buy TDZ computers but use the Intense 3D Pro 2200 instead of RealiZm cards will be able to purchase the optional accelerators.

The Intense 3D Pro 2200 ranges in price from $2,399, without any on-board texture memory, up to $3,394 with 16 megabytes of texture memory. IBM says it will start selling the Intense3D Pro 2200 in Pentium II Intellistation computers that will start shipping in October.

Intergraph also announced that it has dropped the base price of the Intense3D Pro 1000 from $1,999 to $1,666. Contact the Consumer Products Division of Intergraph Computer Systems. In the United States, call (800) 763-0242.

DUAL-PROCESSOR DRIVERS

Dynamic Pictures has demonstrated that rewriting its drivers for multiple CPU workstations can bring a major improvement in interactivity with three-D models. At Siggraph 97, the company showed off its new PowerThreads technology, developed for multiprocessor Pentium Pro and Pentium II computers. PowerThreads also takes advantage of the multiple processing chips on board its Oxygen 202 and 102 adapters. The new driver will not, however, bring much benefit for the Oxygen 102, which has a single Oxygen graphics engine, said a Dynamic Pictures representative.

In its demonstration, Dynamic Pictures showed that an IBM Intellistation with two 266-megahertz Pentium II microprocessors, was able to rotate a Pro Engineer trail file 40 percent faster than an identically configured Intellistation with just one CPU. The trail file used was

Pro/E's head set.asm example assembly that ships with most versions of Pro/E. The computers were asked to keep track of the time it took to rotate the assembly. It took 75 seconds on the uniprocessor machine and 55 seconds on the dual processor. Both machines were equipped with an Oxygen 402 accelerator with 32 megabytes of display memory.

PowerThreads technology will be integrated into upcoming drivers for Microsoft Windows NT and will be available at no cost to registered Dynamic Pictures customers. Customers will be able to download the file from Dynamic Pictures's World Wide Web site, and the file will also be available on a CD-ROM. (For details on the Oxygen adapters, see the December 1996 CAD Report.) Contact: Dynamic Pictures, 5225 Betsy Ross Drive, Santa Clara, California 95054 Telephone: (408) 327-9000 FAX: (408) 327-9010 e-mail: info@dypic.com Web site: http://www.dypic.com.

NT WORKSTATION MARKET SHARES

Reflecting the NT domain's growing stature, Dataquest for the first time released Windows NT workstation market share estimates (see the accompanying charts). More than 61,384 Windows NT workstations were shipped in the first quarter of 1997, 23.6 percent of total workstation volume, according to Dataquest. Revenues were $429 million, or 12.4 percent of total workstation sales. HP was the NT workstation volume leader, while Intergraph became the revenue leader. Dataquest's Peter Ffouks cautioned that the youthful NT workstation market is very dynamic, and market shares are likely to fluctuate rapidly.

The revenue data, for example, reflects the reality that Intergraph has pretty much had the top end of the market for Windows NT on Intel computers all to itself. Only Alpha-based computers from Digital have offered faster performance than that offered by Intergraph's RealiZm-based workstations. As a result, Intergraph has been able to sell units with more expensive average sales prices. Intergraph's claim on the top of the market, however, will be challenged next month, when HP introduces its next generation of Windows NT workstations.

... Alias/Wavefront subsidiary announced development plans for a Windows NT version of its three-D **animation** product called **Maya** . SGI also distributed a press **release** from Autodesk's Kinetix subsidiary announcing that its new 3D Studio MAX R2 will support...

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Alias Wavefront Ships Maya With Enthusiastic Customer Support

DATE: February 17, 1998 13:07 EST WORD COUNT: 1,227

LONDONFeb. 17 /PRNewswire/ -- Alias Wavefront, a subsidiary of Silicon Graphics, Inc. (NYSE: SGI), today announced the shipping of Maya, its next-generation 3D animation software product. At launch events held in London, New York, Los Angeles and Tokyo, Alias Wavefront president, Penny Wilson, and chief technology officer, Tom Williams, were joined by a number of high-profile international customers to demonstrate the competitive advantage delivered by **Maya** . To complement the **release** of **Maya** ,

Alias Wavefront also announced the availability of new advanced modules and a number of third-party developed plug-ins.

Maya is a dramatically new approach to character animation and further strengthens the company's current leadership in visual effects technology. The advanced architecture of Maya delivers unmatched system speed and a streamlined workflow resulting in significantly increased productivity. Maya provides an unprecedented level of openness allowing customers to easily extend the system to meet their specific production requirements. "Throughout the development of Maya, customer input has been an essential component," explained Penny Wilson. "We are thrilled that we can celebrate the arrival of Maya with many of the customers that have helped make the product a true innovation."

Representatives from Blue Sky VIFX, Cinesite, Dream Pictures Studio, Dream Quest Images, GLC Productions, Kleiser-Walczak, Rhonda Graphics, Square, Santa Barbara Studios and Imagination Plantation were among many of the BETA customers who went on record with their support for Maya see attached customer press releases and Maya video for additional information .

Revolutionary New Tools

Maya leads the industry in the following key areas:

Bringing Characters To Life - With Maya, Alias Wavefront introduces a breakthrough approach to bringing digital characters to life that surpasses all other animation software. The unique character animation capabilities in Maya free the animator to concentrate on the creative process while providing technical directors (TDs) with more powerful access to the technology than ever before. Maya allows TDs to build characters with embedded behaviors and higher level controls so that animators can quickly and intuitively interact with them as digital puppets.

Explosive Visual Effects - With Maya, Alias Wavefront builds on its reputation for powerful visual effects technology by delivering the broadest arsenal of tools with a tightly integrated workflow for the world's best visual effects system. Maya combines an extensible and fully-integrated particle system with rigid and soft body dynamics technology for creating realistic simulations that accurately reflect physical forces on objects as they collide, bounce, roll, slide and deform without the time consuming process of key framing. The mood of a scene can be easily set with extensive lighting controls that let animators quickly experiment with position, color, fall off and light intensity. Maya integrates a range of sophisticated rendering features including shader networks to enable artists to quickly create rich, complex shots that blend the digital world seamlessly with reality.

System Architecture - Maya dramatically increases the rate at which high-quality computer graphics can be produced. For Maya, Alias Wavefront developed many architectural innovations to establish a technical foundation that was built, from the ground up, to deliver unmatched speed and programmability. At the heart of Maya is a comprehensive scripting and command language called MEL (Maya Embedded Language). With MEL, users can extend the system to meet specific production needs using scripts ranging from simple macros to complex programs. Additionally, the OpenMaya C++ API lets programmers extend the native power of Maya through a rich, high bandwidth programming interface.

User Interface - Maya features a number of workflow innovations designed to significantly enhance user productivity by speeding both the

learning process of the novice and the throughput of expert users. For example: a transparent Hotbox Menu, similar to the heads-up displays found in modern jet fighters, provides artists with convenient access to tools while maintaining full-screen workspaces that aren't crowded by menus and icons. MEL can also be used to write simple scripts to automate repetitive tasks or design an environment custom-made for the artist or specific projects.

Maya Advanced Modules

Three advanced modules which extend the capabilities of the Maya system are as follows:

Maya F/X - high-performance fully-integrated soft body dynamics, particle dynamics and particle rendering for advanced visual effects and realistic character animation;

Maya PowerModeler - an advanced set of modeling tools that gives animators the precision needed to create real-world designs where adherence to specific values, such as the radius of a rounded corner, are critical.

Maya Artisan - a new modeling and animation tool with a revolutionary interface that gives users the creative control and intuitiveness of traditional artists' brushes and sculpting tools see attached Maya Artisan press release for additional information .

Maya Conductors Program

Along with the advanced modules, Alias Wavefront unveiled its plans for extending the functionality of Maya through the Maya Conductors Program. The Conductors Program encourages the development of software plug-ins by providing third-party developers with dedicated support, marketing assistance and special tools that aid in the creation of Maya-compatible programs. Already, the program has over ten software developers, including Pixar Animation Studios, Radical Entertainment, Metropolis Digital, Inc., Zaxwerks Inc., Second Nature Industries, and DreamTeam Ltd. see attached Conductors Program press release for additional information .

Maya Price & Availability

Maya will start shipping in February 1998 and will be available starting at $10,000 for the base package, $10,000 for each of the advanced modules, Maya F/X and Maya PowerModeler and $7,500 for the Maya Artisan advanced module. For a limited time, Alias Wavefront will be offering Maya with all three advanced modules plus one year of support for $30,000. Price is indicated in US funds and will vary outside of the US.

Alias Wavefront provides artists with advanced computer graphics software that helps unleash the power of their creativity. As the world's leading innovator of 2D and 3D graphics technology, Alias Wavefront develops software for the film and video, games, interactive media, industrial design and visualization markets. Alias Wavefront's film and video customers include Cinesite, CNN, Digital Domain, Digital Pictures Studio, Dream Quest Images, Industrial Light + Magic, Metrolight Studios, NBC, Pixar, Sony Pictures Imageworks, The Walt Disney Company and Warner Bros. Games and interactive media developers include Acclaim, CAPCOM, Electronic Arts, Iguana Entertainment, Interplay, Kronos Digital Entertainment, NAMCO, Nintendo, SEGA, Sony Interactive, Square, Virtual Worlds Entertainment and Williams/Bally Midway.

Based in Toronto, Alias Wavefront is a wholly owned, independent

software subsidiary of Silicon Graphics, Inc. Alias Wavefront has worldwide distribution via a network of Channel Partners and sales offices located in North America, Europe and Asia. For more information on products, readers can access Alias Wavefront's website at www.aw.sgi.com. Readers in North America can also call 800-447-2542 for the location of the nearest sales office or Channel Partner in their area.

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Company News On-Call: http://www.prnewswire.com or fax, 800-758-5804, ext. 795806 PR

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(SGI)

... by a number of high-profile international customers to demonstrate the competitive advantage delivered by **Maya** . To complement the **release** of **Maya** , **Alias Wavefront** also announced the availability of new advanced modules and a number of third-party developed...
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Maya Complete 2

Advanced rendering and animation lead the list of improvements

BY GEORGE MAESTRI

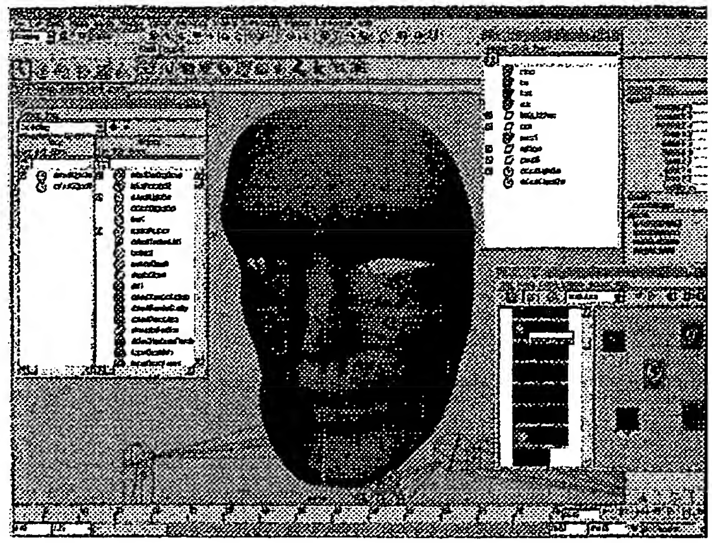
Alias|Wavefront's Maya is the de facto standard for high-end 3D character and effects animation. Maya 2 adds to this heritage with several upgrades, particularly in rendering and animation, making it even more robust and efficient. Also new is a Relationship Editor, which lets you edit the way objects are grouped and linked.

Maya 2 is available in two versions. Maya Complete ($7495) includes modeling, rendering, animation, and dynamics tools, the Artisan and Maya FX modules, and MEL, an open interface for programming and scripting Maya. Maya Unlimited ($16,000) adds Maya Live, Maya Fur, Maya Cloth, and numerous advanced modeling features. Maya Complete, reviewed here, contains plenty of power for most modeling, animation, and effects applications.

In terms of modeling, Complete 2 sports enhanced NURBS capabilities. One of my favorites is the ability to move control vertices along the surface of an object in the U and V coordinates. This is handy for rearranging the underlying detail of an object. One of Maya's best modeling tools is Artisan, which enables you to deform and sculpt a surface using a virtual paintbrush. Last year, Artisan was a separate module that cost $5000, but now it's part of Complete 2.

A modeling limitation in Complete 2 is that the software's subdivision surfaces do not animate, which means you can't model polygonal surfaces in low resolution and then automatically smooth them to a higher resolution, something you can do in Maya Unlimited 2. Although this is certainly a drawback, you can get around it somewhat by using the software's new wrap deformer tool, which uses the shape of a second object to deform a first.

Additional enhancements to animation include several non-linear deformers that enable you to bend, flare, twist, and squash objects. Character animators will also like the smooth skinning function, with which vertices can now be influenced by more than one joint, which reduces the need for flexors and lattice deformers.



With Maya Complete 2's Relationship Editor, you can edit the way objects are grouped and linked. This capability includes linking lights to objects, and editing shading groups, sets, deformers, partitions, and layers.

Complete 2 also includes a character set. In 3D animation software, most characters are built from different objects—from the skin of the character to the skeletons that deform it—and managing these objects can be a chore. Complete 2 addresses this issue by allowing these disparate objects to be grouped as a character.

For keyframing, Complete 2 adds some new features aimed at character animators. These include a breakdown key that affects the keyframes surrounding it so that moving the breakdown maintains the shape of the animation curve, and an in-between function, which inserts time into an animation, again without changing the shape of the curve.

Maya Complete 2

PRICE: $7495

MINIMUM SYSTEM REQUIREMENTS: Irix: Version 6.5, 24-bit graphics, 128MB of RAM, 220MB of disk space Windows NT: NT 4.0 (service pack 5), 128MB of RAM, 220MB of disk space, three-button mouse, approved OpenGL card

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Though still slower than in other packages, rendering is noticeably faster in this version of Maya, and the renderer now takes advantage of multiple processors. The biggest enhancement is Maya's new IPR (Interactive Photorealistic Renderer), which allows you to render only those pixels that changed since the last render. This speeds up workflow tremendously.

The next version of Maya, 2.5, was announced several months ago and began shipping at press time. It will provide a feature called Paint Effects, which lets users paint and animate complex organic and painterly detail into 3D space. Additional features slated for the 2.5 release of Maya Complete include Maya Builder, which will enable game developers and programmers to create polygon-based content.

Altogether, Maya 2 boasts several great new features, particularly IPR and the new animation tools. The package still needs tweaking in terms of polygonal modeling and animation, but for the most part it's robust and powerful. Maya is an excellent all-around package, and is certainly at home in almost any production environment.

George Maestri is a writer and animator living in Los Angeles.

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1 **Design and implementation of the Maya Renderer**
Sung, K.; Craighead, J.; Changyaw Wang; Bakshi, S.; Pearce, A.; Woo, A.;
Computer Graphics and Applications, 1998. Pacific Graphics '98. Sixth Pacific Conference on , 2 Oct. 1998
Pages:150 - 159, 231

[Abstract] [PDF Full-Text (144 KB)] **IEEE CNF**

Design and Implementation of the Maya Renderer

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Abstract

Maya is the new 3D software package recently released by Alias|Wavefront for creating state-of-the-art character animation and visual effects. Built on a next-generation advanced architecture, Maya delivers high speed interaction and high productivity for its users. In the Fall of 1995, the Rendering Team at Alias|Wavefront started from scratch to design and implement a renderer for the Maya project. This was a very challenging task, requiring the efficient generation of high-quality images for a next-generation 3D application that was still under development. In addition, we were expected to match or exceed the capabilities of our existing popular rendering products (as well as those from our competitors). In January of 1998, the all-new renderer was delivered with Maya 1.0. It includes a comprehensive user interface that is well integrated with the rest of the system, and a batch renderer that is capable of efficiently generating a full spectrum of high-quality visual effects. Currently, there are high-end computer graphics (CG) productions in progress that are using the Maya renderer.

In this paper, we will concentrate on our batch renderer implementation effort. We will describe the philosophy, design decisions, and the tasks we set out to achieve in 1995. We will then evaluate the delivered system based on images generated with the renderer.

1. Introduction

Alias|Wavefront undertook the Project Maya Initiative to redefine the standard for high end 3D animation software system. In the Fall of 1995, the Rendering Team was given the mandate of supporting the final phase of the 3D creative process, the generation of 3D images. We were given a specific set of deadlines and the simple to state, and yet difficult to achieve requirement of generating high quality images efficiently. Within those constraints, we were free to define the system we wished to deliver. It was clear from the beginning that the most challenging tasks were not related to the state-of-the-art technologies. Our first problem was that we had to integrate well with the then evolving Maya project initiative. Secondly, we had to deliver a batch rendering system that, at least matched (or exceeded) the quality of our existing popular rendering systems. Both the Alias® Renderer [3], and the Wavefront Explore™ Renderer [2] are enormously popular and successful products. Finally, the Rendering Team had to ensure that a (even partially) functional renderer was available to the rest of the Maya development team at all times, even in the early phases of the Maya project development. In the beginning, we considered the option of defining wrapper modules over our existing rendering products. It quickly became obvious that taking such an approach would mean terribly boring work for us and would forfeit many possibilities for improvements. More importantly, we would miss the great opportunity of defining and building an architecture that is open to users and easily expandable to future rendering needs.

With these considerations, we defined the requirements of the system we wished to build. To minimize our risks and to be able to supply a functional renderer at all times, the actual implementation of our system was carried out by first interfacing the Alias Renderer with Maya, and then replacing the entire renderer *almost* transparently to the rest of the Maya development team. Throughout the two and a half years of Maya development, the batch renderer was always functional, although at times, the image quality and the performance might have been less than perfect. It is important to point out that a major portion of the Maya Renderer design and development effort was devoted to the integration with the rest of the Maya system, and its user interface. This paper does not address any of the issues related to those areas; we will only concentrate on the batch rendering system.

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In the next section, we describe the minimal set of requirements we defined for ourselves. We then describe the Maya renderer architecture in Section 3. Section 4 describes our implementation in detail with a view on how we achieved the goals we defined for ourselves. Section 5 evaluates our renderer based on images that were generated for various productions.

2. Minimum Requirements

In 1995, when we first started to define the system, it was clear that the team agreed on the characteristics of the renderer that we wanted to build. However, it was much more difficult to have consensus on the details of the actual architecture. As such, we decided to define a set of requirements for ourselves to serve as system design and implementation guidelines. With the 10 years of experience we had in building and maintaining our existing renderers, together with the customer feedback we had collected over the years, we defined 4 major criteria. The idea was that these criteria would not govern the design or the architecture of the renderer but would remain the minimal set of requirements we must satisfy, or at least adequately address, for whatever system we would build.

1. **Flexibility.** From our experience, we understand that it is impossible to always provide exactly what a computer artist may want. We must allow them to unleash their creative power. This is especially true when it comes to the definition of illumination models (or *shaders*) for an object's material properties. For example, some well-known shaders are the *Phong* [15] and the *Blinn* [5] shaders. While useful, these, and other standard shaders, must be replaceable with custom (user written) shaders where desired. Most high-end renderers define an Application Programming Interface (API) to allow the technically fluent users to implement their own shaders. We would likewise provide an API. Furthermore, we would provide a mechanism whereby small and simple expression-like pieces could be combined to form the equivalent of a shader for those users wishing to create custom shaders but not wanting to write programs. Such a building block approach would allow a complete visual interface to shader creation. Finally, the renderer must be flexible and general enough to support all of the paradigms used by our previous products, or those of our competitors. This includes such widely different approaches as Alias Renderer's hierarchical layered shaders and textures [3], Wavefront Explore's shader maker [4] and PIXAR's RenderMan shading language [17].
2. **Image quality.** The importance of image quality cannot be over-emphasized. There are two important details. First, image quality must be consistent over animations. Even as early as 1979 [7], it was recognized that inconsistency over an animation is a major source of annoyance. This problem was especially important to us because our system was meant to support a next generation 3D animation software system. Second, image quality is not related to physical accuracy. Our aim would be to generate images that are *to the expectation* of the artistic Technical Directors.
3. **Performance.** There are two major areas that must be addressed, memory and speed. The requirements for memory are obvious; we must handle scenes with extreme complexity. It is important to remember that the batch renderer is part of the Maya system, so our memory footprint would be bounded below by Maya's. As such, our goal was to control and maintain a low ceiling for memory use throughout the rendering process. For speed, the main philosophy would be to avoid unnecessary work whenever possible and concentrate the computation effort only on the specific problems that need to be fixed. For example, in a typical ray casting (or point sampling) style renderer, geometric anti-aliasing is achieved by casting extra rays. Recall that casting a ray typically means computing visibility along the ray, and performing the shading on the visible geometry. If the cause of the problem is geometric aliasing then the time spent in computing shading is wasted. We wanted to avoid these types of inefficiencies. In addition, it is important to provide incremental alternatives to improve image quality. For example, if the artistic director is not satisfied with the texture quality in a motion blurred sequence, then we must provide a way for improving just the texture quality without affecting the rest of the rendering (either in performance or in the perceived quality of the rest of the generated image).
4. **Unified Solution.** In many existing rendering products, there are separate executables for supporting different visual effects. For example, in our current Alias Rendering products [3], we have a separate executable to support secondary illumination effects (*"ray traced effects")*. While in other systems, more advanced effects are simply not supported. For example, PIXAR's Photorealistic RenderMan [4] and the 3D Studio Max Renderer [12] do not support tracing of secondary rays (or shadow rays). Other extreme examples are systems designed to handle more advanced effects, and consequently, the performance of these systems suffers for simple effects. For example, Radiance [18] is designed to solve general global illumination problems, and Mental Ray [16] is designed to support ray trace style renderings. Both of these systems perform very well

for their specific problem domain but suffer in performance otherwise. For example, a ray trace style renderer must build an acceleration structure even when there are no secondary illumination effect in an image. We wanted our system to be general purpose, and yet support the more advanced visual effects without degradation in performance (in either memory or speed). Examples of these visual effects are secondary illumination (``ray traced effects''), soft shadows, volumetric fog, particle systems, motion blur, etc.

Obviously, there are other very important requirements for any software system. For example, software robustness (including crashes, memory leakage) is very important simply because we must support the rendering of animation sequences. Another example is that with the diversified machine architectures available; our system must be implemented in a platform independent way. These requirements are not specific to the building of renderers and we will not discuss them in this paper.

3. Overview of the Maya Renderer.

In this section, we follow the flow and transformations of data in the Maya Renderer to provide an overview of the system we have built. After this high level description, we will discuss the implementation details of how we address each of the defined requirements in the next Section.

- **Read Geometry**. All the objects with defined shading properties in the Maya scene database are examined by the renderer. Only the ones that are inside the viewing frustum are considered for rendering and a bounding box for each of these objects is built. In a similar manner, objects that participate in shadow casting are clipped against the corresponding light source's illuminating volume. Objects that participate in ray tracing effects are always considered by the renderer.
- **Compute shadow depth map** [20]. Depth maps are only computed for light sources with an illuminating volume intersecting the camera viewing frustum. Computed depth maps are divided into tiles and then compressed. During rendering, only the tiles for the active regions (the region we are shading) of the depth map are decompressed.
- **Build image tiling system**. The image to be generated is subdivided into smaller regions (tiles) by a quadtree-subdivision algorithm. All supported renderable primitive types know how to approximate their cost (in units of triangles). This cost is used to approximate the cost in memory to render a tile. The quadtree subdivision stops when the cost to render a tile is lower than a user specified threshold. In this way, the renderer attempts to maintain a constant memory footprint.
- **Scan conversion for a tile**. Notice that until this point, the only computation we have performed on the objects is computing their bounding boxes. To avoid performing further computation for objects that are entirely occluded, we first sort the objects by their depth, then project each object into screen space in front to back order. Projection to screen space involves initializing an object's shading state, tessellating the object into triangles (when possible), and scan converting the triangles into corresponding screen masks (or fragments) [11, 6]. Since the computation is performed from the front to back, the process can stop as soon as the entire pixel is covered by opaque objects. In this way, completely occluded objects will never be tessellated and their shading state will never be initialized. Only one tessellation is performed for different instances of the same object, with the tessellated triangles shared among all the instances. As illustrated in Figure 1, for implicitly defined primitives (e.g. volumetric objects, or particle systems), the bounding boxes are used as placeholders during scan conversion. At the end of scan conversion, each pixel in the tile contains a list of potentially visible fragments.
- **Render a tile: compute visibility**. For each pixel in the tile, fragments are sorted and inter-penetrations are resolved when possible. For potentially transparent fragments, inter-penetrations cannot be resolved until shaded results are available. The fragments of bounding boxes from implicit primitives are ignored at this stage. If motion-blurred objects are visible through a pixel, we perform point sampling to compute the exact visibility in time [14]. In this case, visibility information from the neighboring pixels are examined and extra point sampling in the pixel may be performed in order to achieve a consistent visibility solution in the region around that pixel. After this point, the renderer assumes that the visibility problem is satisfactorily solved and the remaining problem is to compute the correct shading for the visible objects.

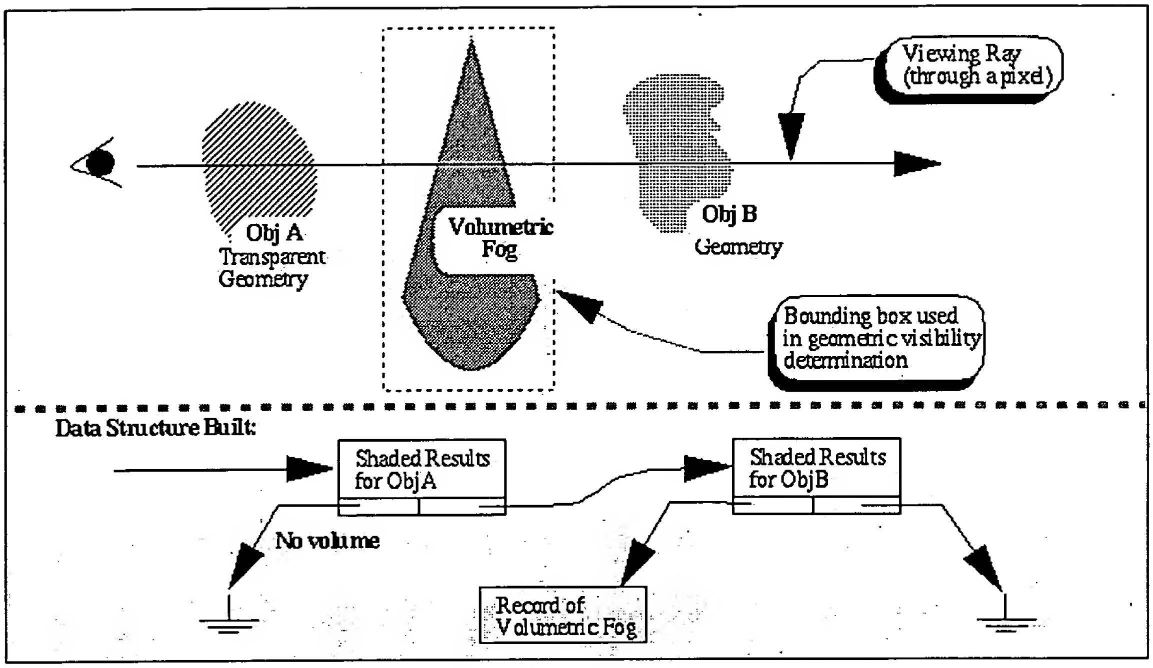

Figure 1: Volumetric Primitives.

- **Render a tile: shade geometry**. To avoid excessive shadings, all fragments visible through a pixel that belong to the same object are grouped together. A user defined number of shading samples (by default this is 1) is taken for each object that is visible through a pixel. During shading, if a shader has its ray tracing functionality switched on (either secondary illumination, or shadow computation), the ray tracer will be invoked. The acceleration structure is built lazily, during tracing of rays.
- **Render a tile: computation for volumetric primitives**. Volumetric primitives do not participate in the screen mask visibility operations because they are typically implicitly defined, and thus can be difficult and inefficient to tessellate for scan conversion. Furthermore, the shading of volumetric primitives usually requires a visible interval in depth, whereas a screen mask is designed for computing projected surface coverage on the screen. As illustrated in Figure 1, placeholders of volumetric primitives (*Record of Volumetric Fog* in Figure 1) are inserted in the data structure. As in the cases of geometric primitives, placeholders of the same volumetric object are grouped together into *vectors*. For each vector, viewing rays are intersected with the volumetric primitive, and the visible intervals are shaded. In our system, particle systems are considered as a special case *(subclass)* of the volumetric primitive type.
- **Render a tile: adaptive extra shading sampling**. Shaded results from the same object are collected and per-object contrasts are computed. For objects with contrast violations (contrast threshold is user controllable) extra shading samples are taken. We take a fixed number of temporal samples for motion blur and do not perform adaptive super sampling in time.
- **Render a tile: multi-pixel reconstruction**. Shaded results are reconstructed with a 3 pixel by 3 pixel quadratic bspline filter. Each pixel is subdivided into 4x4 regions, and pre-convolved results are stored in 9 different tables[1]. During reconstruction, each shaded sample uses the screen mask from the fragment to perform look-ups from the pre-convolved table. Neither the filter size, nor the filter function can be changed for Maya1.0 (this restriction is removed in Maya1.5).

4. Implementation

4.1. Flexibility

To achieve maximum flexibility and generality of shading it was necessary to separate how shading is performed from the processes doing it. Indeed, the processes - materials, lights, textures, expressions and other modifiers - needed to become independent black

[1] One table is defined for each pixel in the 3x3 kernel. Although 5 of the tables can be derived based on symmetry from the other ones, in this case, the table size is quite small so we store all 9 tables.

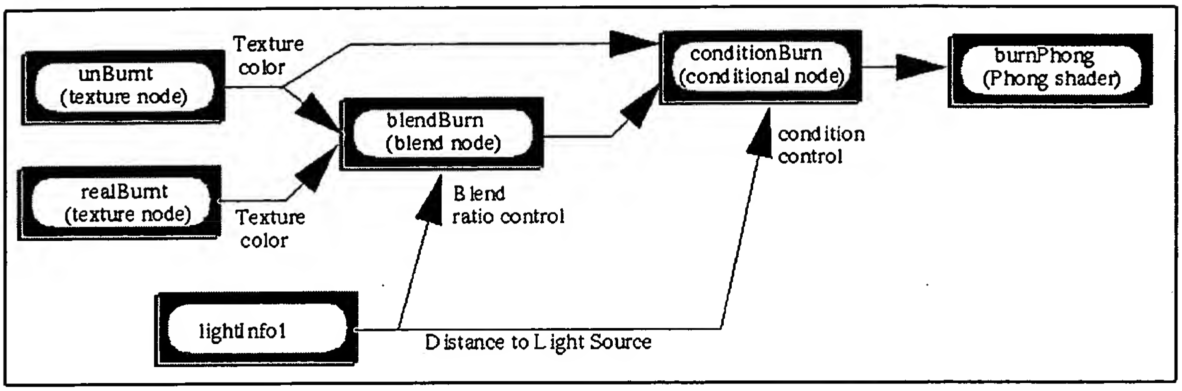

Figure 2: Shading Network for the "Burn" Shader.

boxes that could be interchanged, substituted and interrelated arbitrarily. Since the *Maya Dependency Graph (DG)*[2] [8], complete with an API for user written nodes, was already being developed for basic modeling and animation purposes, it was decided to use the same mechanisms for describing shading. That is, DG nodes would be used for each shading process (such as a texture) and relationships among processes would be handled by DG connections. Thus a shading "look" would be defined by a DG network, and the process of shading would be the evaluation of such a network.

Use of the DG for shading satisfies many of our requirements immediately. However, one extension to the basic DG was required to allow contextual information to flow between the nodes of the shading network, the geometry, and other parts of rendering. The contextual information here is the sample data of the model. Since a sample data describes the point we are shading, this data will be different for each of the large numbers of sample. Making and breaking DG connections to all the relevant pieces for each shading sample would be tedious, confusing, and slow. So a special network evaluator was developed that would automatically link sources and sinks of this contextual information as required during shading. These contextual links came to be known as implicit connections, and they occur only when a "real" connection does not exist. Each "implicit connection" is defined entirely by the name of the data item involved, for example "filterSize". There are approximately 100 such data items that are defined and recognized in Maya 1.0.

Different shading evaluations are possible depending upon what information is needed in a given situation. For example, the transparency may be computed independently first and then used to determine if further shading is required. Another example is that surface shading and volumetric shading may be computed separately. This is all because shading has been defined to be just the evaluation of samples and is completely decoupled from the tiling and visibility aspects of rendering. Furthermore, mechanisms were developed to limit the shading evaluation based upon the information needs of both the processes wanting a shading result and the shading network being evaluated.

The Maya DG evaluation is interpretive and it does not take advantage of any invariance inherent in the network. Since shading would have its own evaluator to traverse the network anyway, it was decided to make it a two pass process that would partially evaluate the network on the first pass by factoring out all frame constant considerations, and finish the (now simpler and faster) evaluation for each shading sample as a second pass. This strategy fits well with the code and remainder of the rendering process.

In the following example, a *burn shader*[3] is defined by using geometric distance to control surface material property. The shader allows a user to use a light source to ``burn'' geometry by moving the light close to the geometry. Please refer to Figure 2; this shader is implemented by connecting the output of *conditionBurn* (a conditional node) to the color channel of the *burnPhong* (a standard Phong node). The *conditionBurn* node uses the distance between the light and the point to be shaded (from the *lightinfo1* node) to determine which of its two inputs should be forwarded to the *burnPhong* node. The inputs to the *conditionBurn* node are the normal color (the *unBurnt* texture node) of the geometry, and a version that is blended with a burnt color (the *realBurnt* texture node). The blending between *unBurnt* and *realBurnt* color is also controlled by the distance of the light. As the distance of the light gets closer, more *realBurnt* color is used in the blending. In this way, as the light source is moved close enough to the geometry, the *conditionBurn* node will stop forwarding the normal *unBurnt* color, and start forwarding the blended version of the color. Thus the color on the geometry will appear to

[2] The Dependency Graph is one of Maya's key architectural components. Every element in Maya, whether it is a curve, surface, etc., is described by either a single node or a series of connected nodes. Each node is defined by an external interface, which is a series of attributes that relate to what the node is designed to accomplish. For example, *translateX* is an attribute of the transform node. These nodes can be inter-connected with connections between their attributes. These connections are also known as dependencies.

[3] This shader was designed by Mark Conahan.

be burnt and the burnt mark will appear to be more severe as the light is moved closer. The whole network was programmed graphically by connecting nodes provided in Maya1.0.

4.2. High Quality

Since we are building a renderer for the next generation animation system, not only do we need to generate high quality images; we must ensure consistency of quality over animations. As in any rendering system, the two major challenges here are to generate consistent visibility and shading results. As described in Section 3, the Maya Renderer completely separated the visibility and shading computations. In this section, we will describe our visibility determination algorithm. Since our shading strategy is tied in with performance considerations, we will discuss our approach to solving the shading consistency problem in Section 4.3.

In the case of the Maya renderer, there are two major considerations in achieving a consistent visibility solution over animations:

1. We must ensure a similar visibility sampling rate for each frame in the animation.
2. We must ensure a sufficiently accurate visibility solution so that the shading process in the later stage of the rendering pipeline would only need to be concerned with shading quality.

The screen mask (or Exact Area Sampling [11], or A-Buffer [6], or coverage bit-mask [1]) visibility approach addresses both of the above concerns naturally. The basic idea is to super sample each pixel at a fixed rate and represent the visible portion of each object with a bit mask (or fragment). In this way, the visibility sampling rate is constant throughout any animation. Since this approach performs super sampling by default, sufficiently accurate results are usually available for the shading process.

The existing screen mask approaches defined uniform sampling patterns to compute visibility. For example, [6] defined a 4x8 uniform sampling pattern, and [2] defined a 5x5 uniform sampling pattern. Since visibility is represented by a bit-mask, the number of bits in the sampling pattern is typically restricted by the size of a word (for now, this is usually 32 bits). There are two major restrictions in the existing screen mask approaches:

1. With 32-bit word size, it is very difficult to take advantage of all the bits. The 4x8 uniform sampling of [6] results in biased solutions. This is because there are more samples in the x-direction then in the y-direction. Annoying artifact may result from animations of rotating objects. The 5x5 sampling pattern of [2] means 7 valuable bits are wasted.
2. Since all the sub-regions defined by the pattern are sampled, when geometric aliasing occures, it becomes very difficult to perform super-sampling.

In our screen mask approach, a nxn grid is defined and m sampling positions are *sparsely distributed* in the grid to compute coverage for visibility determination. In the current implementation, each pixel is divided into 32x32 regions, and 32 multi-jittered [8] samples occupy 32 of the 1024 sub-pixel regions. In this way, all the 32 bits in a word can be utilized. With a multi-jittered sampling pattern, we are able to achieve higher and unbiased geometric anti-aliasing quality than that from a uniform sampling pattern. Furthermore, in the future, one natural way for us to achieve even higher geometric anti-aliasing quality is by increasing the number of samples in the 1024 sub-pixel regions.

4.3. Performance

As described, our concerns are memory and speed requirements. Given the sophistication of modern-day graphics designers, it is unrealistic to try to predict the complexity of the database that must be handled. This means our system must be able to work on different parts of the image using only parts of the scene database and release system resources whenever possible. In this section, we discuss the specific approaches we took to address the memory and speed requirements.

Atomic super sampling [22]. It has long been recognized that, although very high frequency information must be approximated during the rendering process, only low sampling densities are required for most portions of typical scenes [19,11]. Adaptive super sampling is the obvious approach to take advantage of this characteristic where dense sampling is engaged only when necessary. However, typical adaptive super sampling approaches do not take advantage of the fact that high frequency information in different domains may not be related. These approaches (e.g. [13]) perform super sampling in all domains at the same time. Using a simple Phong sphere illuminated by a light source as an example, the silhouette of the sphere geometry requires extra visibility samples and the Phong highlight boundary requires denser shading samples. Most of the existing adaptive super sampling approaches would take extra *general* (visibility and shading) samples for both the silhouette and the highlight boundaries. By *atomic super sampling*, we refer to the fact that we try to solve each problem domain separately in an attempt to avoid unnecessary computations.

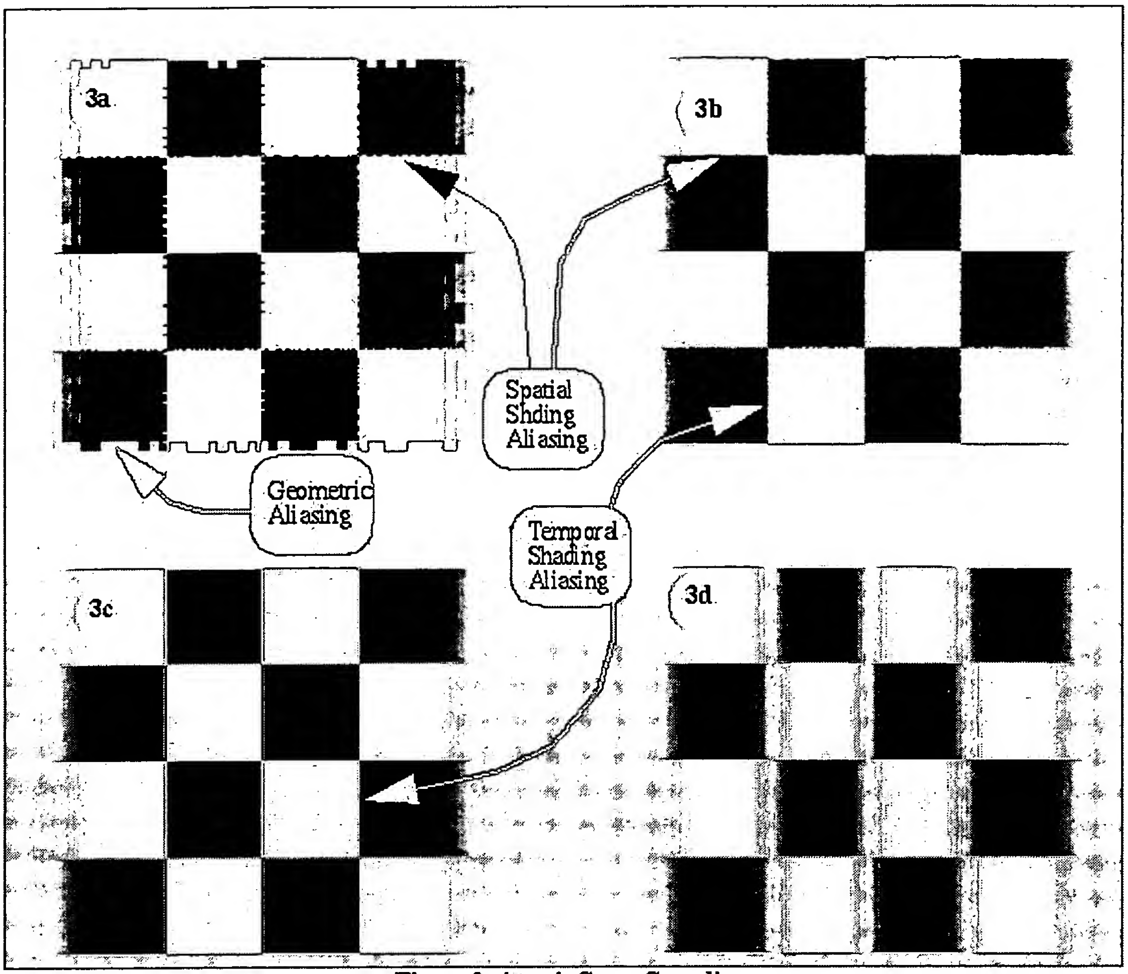

Figure 3: Atomic Super Sampling

We will use the example as shown in Figure 3 to illustrate the essence of our atomic super sampling approach. In Figure 3, the checkered polygon is moving horizontally. The 3a image is the low quality rendition where geometric, spatial, and temporal aliasing are all noticeable. The 3b image shows the results of geometric anti-aliasing. Notice the edges of the polygon are now *smoothed* but the checker texture boundaries are still quite noisy. This spatial shading aliasing problem is eliminated in the 3c image (by adaptively shading the high frequency boundaries without extra visibility computations). However, this image still does not look quite right because the checker texture appears to be stationary on the moving polygon. This is a result of temporal shading aliasing and this problem can be rectified by taking extra shading samples in time, as shown in the 3d image. In this way, we solve individual problems in different domains. A very desirable side benefit of the atomic super sampling approach is that we have given our user the ultimate control over the image quality. For example, if for some reasons a user *likes* the geometric aliasing effect on the polygon in the 3a image, and demands high quality motion texturing from the 3d image, we will be able to generate the desired effects. More importantly, we will not be paying the penalty (in speed and memory) for spatial and geometric anti-aliasing when we only need to increase the sampling in time.

Lazy evaluations. Whenever possible, we avoid and delay computations until we absolutely have to perform them. For example, the tessellation of an object is delayed until the visibility process is fairly confident that the object is visible. In this way, objects that are completely occluded by others may never be tessellated. Lazy evaluation is also used for shading initialization, file texture loading (and Mipmap pyramid building), and building of the ray tracer's acceleration structure.

Vectorization. To exploit hardware cache coherency, shading samples of the same object from different pixels are grouped together into a *vector* of shading requests. The shading process accepts and computes the results for

one vector of shading requests at a time. All of the shading nodes in Maya renderer are *vectorized*, where each node computes the results for a set (vector) of input data. Instead of computing the color for one visible position each time, our shader nodes expect a vector of visible positions at each invocation and will compute a vector of resulting colors. For example, from our experience with vectorizing particle system's visibility computation, we have observed an average speed up of 2 times. The entire rendering system is designed and optimized to produce and process vectors of data.

Tile based rendering. As described in Section 3, image generation is tile based, and so is shadow depth map accessing.

Swapping capability. We understand that it is impossible to predict the complexity of the database we must handle. Although we adaptively subdivide the image to find constant memory cost regions to render, there are other indivisible atomic operations that may violate the specified memory requirement. For example, the memory requirement for tessellating and storing the tessellated results of a complex NURBS surface may violate the memory requirement. For this reason, we have decided to support the capability of swapping unused data into a temporary file on disk. There are three major advantages of performing swapping operation ourselves when comparing to that performed by the operating system:

1. We can reuse the heap allocated memory and thus avoid growth in our memory footprint.
2. We can be more intelligent about swapping because we are the owners of the data. We know exactly what is needed at what time, and the exact size of the data. For example, tessellation information can be swapped out as soon as scan conversion is done. Since we know the size of the tessellated data, the actual swapping operation is one logical disk write.
3. We can avoid expensive system context switches.

Currently, we support the swapping of tessellated data, and the ray tracing acceleration data structure. When available disk space becomes low, we destroy the data and regenerate them when they are needed again.

Block Order Texture (BOT). Texture mapping of photographic or hand-drawn images on geometry is one of the most commonly used techniques in increasing the realism of rendered images. It is easy for a moderately complex scene to contain hundreds of high-resolution (e.g. 1kx1k or 2kx2k) file texture maps. Pre-filtered Mipmap [21] versions of these file textures are usually used for consistent high quality renderings. The memory requirements for supporting these file textures quickly become prohibitively expensive. However, there are two interesting characteristics of file textures:

1. In any sub-region of a rendered image, the number of file textures simultaneously referenced by the renderer is typically small.
2. Once a particular file texture is referenced, the probability of that file being referenced again in the neighboring pixels is very high.

With the above observations and some experimentation, we have designed the BOT caching system. In each rendering session, a global *textureCache* with 256 *pages* is defined. Each page is defined to be 8x8 texels. All referenced file textures are converted to the compressed BOT file format and stored on disk, with only the active pages stored in the cache. The cache implements a LRU replacement algorithm, and performs intelligent pre-fetching. With this simple caching scheme, our tests show hit rates of more than 95% without noticeable performance degradation. In this way, we are able to support a large number of file textures with constant memory and speed requirements.

4.4. Unified Solution

With the Maya renderer, we wanted to present the user with a unified solution, one that includes all the effects achievable in the Alias and Explore renderers. This means, besides being able to render NURBS and polygonal surfaces, we must support the rendering of volumetric primitives, light and material glow[4], visual effects generated from particle systems, etc. We also wanted the ability to trace rays (for secondary illumination and shadow computation) to be integrated into the rendering process. Finally, and very importantly, we would like to support motion blurring of every visual effect.

For the benefit of maintainability and future expansions in the core of the rendering system, we do not want to have special cases to support different primitive types (or visual effects). This implies that both the shading and visibility components must be able to handle different primitive types transparently to the basic algorithms. As described in Section 4.1, the Maya renderer has a very flexible shading architecture. An important characteristic of this architecture is that the shading mechanism does not know (or care) what primitive type has invoked the process. For this reason, the core of the shading process does not require special handling for different primitive types. For visibility operations, we have implemented a *hiderWrapper* class hierarchy. This class hierarchy defines the minimum functionality that a primitive type must support in order to

[4] Light glow models the interaction of a bright light on a lens, film or the eyes. Material glow simulates the similar effect of brightly illuminated material causing glowing effects on film or the eyes.

participate in the visibility computation. For example, the *minimum functionality* includes the ability to: approximate cost in triangle units; provide bounding box; tessellate into scan convertible units; etc. At geometry reading time, different wrapper object is created for different primitive types. The core of the tiling system and visibility algorithm works exclusively with hiderWrapper objects. In this way, adding a new primitive type simply means defining a new hiderWrapper subclass.

The decision to integrate ray tracing into the basic renderer was driven by users not wishing to have to decide which renderer to employ. Users think of ray tracing as a mode wherein they select the objects to ray trace, in effect optimizing the rendering process so that only the objects that are deemed necessary are ray traced. While this does allow for greater flexibility, it poses some design challenges for the renderer. Since our primary visibility computation is based on higher resolution screen masks, the point sampling nature of ray tracing implies that primary and secondary geometric anti-aliasing quality may be inconsistent. Since in Maya renderer, ray tracing is a mode for shading operation, aliasing caused by secondary rays will appear as shading contrast violations. As such, we rely on the adaptive shading mechanism for anti-aliasing in secondary illumination effects. Since in all cases, shading is performed based on point sampling of the visible geometry, there is no inconsistency between primary and secondary shading qualities.

5. Results

The final and the most important step in our renderer development is to prove that the system is production ready. Alias|Wavefront had defined several ambitious high quality production projects in the very early stages of Maya's development, for example, *Ruby's Saloon*[5] and *Bingo*[6]. These productions enabled us to validate the software in real production settings. In this section, we first use the results of these projects to demonstrate the production worthiness of our renderer. We then use some other interesting images to highlight other interesting aspect of the system.

``Ruby's Saloon'' is one of the first major productions based entirely on Maya. This is a 94-second animation that exercised many of the Maya renderer's features. Image 1 and Image 2 are frames from this animation. All of the wooden planks on the walls and on the floor are individual NURBS surfaces complete with top and bottom trimmed NURBS surfaces for the ends of each plank. All the planks are defined based on file textures with different placement to give them different looks. There are over 20 lights in Image 2. Many of these lights have glows and fogs associated with them. It is important for the rendering process to compute the visibility of the glowing light source sufficiently accurately so that the glow algorithm can determine how much energy actually reaches the lens. As the dodo bird cycles on the rope, it sometimes partially occludes the glowing light in the background. The Maya renderer swiftly handles this partial occlusion and as one would expect, the glow effects in the animation oscillates with the occlusion. This image also demonstrates the high quality 3D motion blur algorithm implemented in Maya. All of the effects were generated with a single rendering pass. From these two scenes, we see that in a real world, a renderer must be prepared to operate in non-optimal conditions. For example, although none of the top and bottom ends of the wooden planks were ever visible; they are modeled using expensive trimmed NURBS. Another example is that the lanterns in the background are the same as the one shown in Image 5.

Bingo is another production based completely on Maya. This 6-minute animation was chosen as the finale for the *SIGGRAPH'98 Electronic Theater*. Although the Bingo production team did not intend to do so, the production project tested and demonstrated Maya renderer's ability to handle: high geometric complexity, a large number of file textures, and general 3D motion blur. Image 3 is a frame from this animation. The *Balloon Girl*'s hair was rendered using a specialized anisotropic hair shader developed based on Maya's rich API plug-in architecture. This scene makes extensive use of ray tracing (note the reflection of the girl in the balloon). The *Balloon Girl* had to be very carefully modeled as she was shown in several close-ups and subtle emotion and innocence must be conveyed. The Bingo team paid special attention to her eyes. Each eyelash is a semi-transparent piece of geometry and the tears in her eyes are actual animated geometry. When these semi-transparent objects are animated, the renderer must handle cases where there are literally tens of thousands of triangles behind each pixel. The tiling system helped us in maintaining a reasonable footprint.

The *Stone Archway*[7] shown in Image 4 demonstrates the power of Maya Renderer's shading network architecture. Textures were painted for bump maps and color maps of a few stones. These textures were then reused in many different shading networks with modified texture placements and other parameters. In this way, the artists are able to create a natural ``stone look'' with a high degree of variation based on a few simple initial texture designs. The sky shown in the background is procedurally generated, and so is the 3D environment fog that partially obscures the hilly landscape. The elf's skin is defined with a specialized API plug-in skin shader.

[5] Ruby's Saloon Team: Corban Gossett, Kevin ``Bubba'' Lombadi, Jason Schleifer, Chris Ford.

[6] Chris Landreth and the Bingo Team.

[7] Image created by: Gary Mundell, Paul Roy, and Mike Kitchen.

The Lantern[8] of Image 5 has its primary visibility computed with the screen mask approach, while shadow, refraction and reflection were generated via the ray tracer. The shader on the wooden column is defined by an extensive shading network of bump maps derived from procedural wood textures. The shader on the base of the lantern is a layered shader with different layers defining different types of bumps for the natural aging-metallic look. The flame is modeled by a NURBS surface with texture mapped onto the incandescence channel of its shader and wrapped in a light fog. This is an excellent example to demonstrate the flexibility of the shading mechanism, where we have successfully integrated the Alias Renderer's hierarchical layered shaders (the Lantern base) and the Wavefront Explore's shader-maker-style shading network (the wooden column).

The Space Ship[9] in Image 6 has 1332 NURBS, 306 polygonal-meshes, and 17 lights. A reflection map is used to reflect the tunnel on the ship. Procedure fractal textures are mapped onto the specular channel to introduce imperfection on the metal surfaces. The rusty surface is a layered shader with three different rusts. The shader for the engine-exhaust is defined through a combination of light fog, shader glow, and light glow. The 2kx1k image took about 13 minutes to render on an SGI R10k with 256MB RAM.

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Compatability and Interaction Style In Computer Graphics

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Introduction

Recent trends in human computer interaction have focused on representations based on physical reality [4, 5, 6, 8]. The idea is to provide richer, more intuitive handles for control and manipulation compared to traditional graphical user interfaces (GUIs) using a mouse. This trend underscores the need to examine the concept of manipulation and to further understand what we *want* to manipulate versus what we *can* easily manipulate. Implicit in this is the notion that the bias of the UI is often incompatible with user needs.

The main goal of UI design is to reduce complexity while augmenting the ability of users to get their work done. A fundamental belief underlying our research is that complexity lies not only in what is purchased from the software and hardware manufacturers, but also in what the user creates with it. It is not just a question of making buttons and menus easier to learn and more efficient to use. It is also a question of "Given that I've created this surface in this way, how can it now be modified to achieve my current design objective?" (The observation is that how the user created the surface in the first place will affect the answer to the question.) Our thesis is that appropriate design of the system can minimize both kinds of complexity: that inherent in accessing the functionality provided by the vendor, *and* that created by the user. The literature focuses on the former. In what follows, we investigate some of the issues in achieving the latter. In so doing, we structure our discussion around questions of *compatibility*.

Three Perspectives on Compatibility

When we consider manipulation in the context of 2D and 3D graphics applications, we often consider properties of the input device such as degrees of freedom, and how well the device is capable of moving points or shapes in this space. That is, how well can the user move and adjust interactive widgets as well as directly transform geometry (e.g., adjust points, curves and surfaces). What is often not considered, however, is the ease of manipulating the underlying structure of the graphics (e.g., the deep structure of the geometry, as represented by the scene graph, etc.), even when these are data that were directly or indirectly created by that same user.

Many users, especially artists, do not understand the deep structure, or how it is represented — in fact, many prefer not to. However providing access and acquiring such understanding is often necessary for users to achieve their goals. Thus, we must find ways of exposing the deep structure to the user in ways that are compatible, intuitive and efficient, and which enable the user to work at this level when appropriate.

To explore this issue, we examine three styles of interaction in terms of their ability to support manipulation of both the deep and surface levels of the graphics. We do so by considering the issue of *compatibility* between input and output devices in addition to the ability of the user to manipulate internal representations ("deep structure") as well as external representations ("surface structure") of the application data. This is somewhat akin to the model-view-control organizing structure of SmallTalk [7]. Let us look at each one of these compatibilities.

- *Input with output devices*: Does the input device match the capabilities of the output display?
- *User interface with the ability to manipulate internal representation (access to "deep structure")*: Can the user interface effectively manipulate the internal representation of the application data stream?
- *User interface with the ability to manipulate external representation (access to "surface structure")*: Can the user interface effectively manipulate the artifacts generated by the internal representations?

For example, let us consider a form-based UI on a database of records that use an alphanumeric keypad input device. From the first perspective, this has good compatibility since the primary type of data being input and displayed is alpha-numeric. The deep structure might be considered the layout of the forms, and what attributes of the underlying database are exposed and in what relationship. Since layout, at least, is a spatial thing, the keyboard would likely have low compatibility, compared to a mouse, in terms of interacting at this level. Finally, in interacting with the fields exposed, the surface structure, there is medium to good compatibility. In entering the alphanumeric data the compatibility is high. However, tabbing from field to field using the keyboard may often be less compatible than doing so by selection with a mouse.

In this paper we explore the progression of manipulation as it relates to input devices, deep structure and surface structure. We do this by giving two historical examples and then discuss a new trend which we call "interactive assemblages." We will frame our discussion within the context of sophisticated graphics applications such as computer aided design, modeling, compositing and animation.

Example 1: APL and Teletype

I/O Compatibility — High
UI to Manipulate Deep Structure — High
UI to Manipulate Surface Structure — Low

To begin, consider the use of the programming language APL in computer graphics in the 1960s. The language was cryptic and terse, but the matrix handling was wonderful. "The power of APL comes from its direct manipulation of n-dimensional arrays of data. The APL primitives express broad ideas of data manipulation. These rich and powerful primitives can be strung together to perform in one line what would require pages in other programming languages." [1] Interaction was via an IBM Selectric typewriter-like terminal, and compared to the card-punch readers typical of the era, it was very interactive.

I/O Compatibility — High
The input devices (characters on the keyboard) and the output (printed characters) had a strong compatibility. IBM Selectric typewriters were very popular and familiar to users. Moreover, the symbolic nature of the language lent itself to typing.

UI to Manipulate Deep Structure — High
There was a high compatibility in the manipulation of the deep structure of the graphics. This was by virtue of the language's facility in manipulating n-dimensional arrays, performing matrix multiplication operations and programming new functionality.

UI to Manipulate Surface Structure — Low
However, there was a strong incompatibility in the manipulation of the surface structure of the graphics. APL processed numeric arrays of data, not graphics images per se. While the numeric arrays may represent a graphical image, such as a set of curves, a user could not *directly* adjust the contour of a curve within the graphical domain.

Consequently, the user was forced to function exclusively at the abstraction level of the graphics, manipulating the internal representations, or deep structure. The user interface was designed and optimized to facilitate the manipulation of the graphics as represented by the APL notation, not by way of the pictures themselves. Nevertheless, APL was used in the 1970s to produce a number of innovative animations such as by Judson Rosebush's company, Digital Effects Inc.

Example 2: GUI Direct Manipulation

I/O Compatibility — High
UI to Manipulate Deep Structure — Low
UI to Manipulate Surface Structure — High

In this example we leap ahead approximately 20 years and consider the shift towards *direct manipulation* through the development of the graphical user interface (GUI). The GUI significantly improved our ability to manipulate the surface structure which was so lacking in the previous example.

I/O Compatibility — High
The high compatibility of the input and output devices with GUIs is based on the use of graphical metaphors. Tools and other entities are represented graphically, often as icons, and one interacts with them using generic actions such as pointing and dragging. Interaction is mediated through the use of a graphical input device such as a mouse, tablet, trackball or touch screen, typically in conjunction with a pixel addressable graphics display. While graphical representations and metaphors are used to regulate input and output, there is still a level of indirection employed which serves as an abstraction above that of physical reality (for example, with a GUI one doesn't grab a document to move it up or down. One does this indirectly, using a widget such as a scroll bar or scroll arrow, which is itself a metaphoric icon).

Moreover, while graphically the GUI's output is explicitly representational, the input is limited and generic. For example, while I may be presented with a graphical ruler, the typically one-handed, single device input mechanisms available only permit me to perform a small subset of the overall bimanual actions or gestures that I might employ with a real ruler. Just compare how you perform actions like bending, flipping, squeezing, shaking, tilting or moving objects in the physical world with how you do so using so-called "direct manipulation" with a GUI.

In summary, while input and output are compatible in manipulating the surface structure, we need to keep in mind that this holds true only within the range of actions available. Between how one interacts with the graphical objects in the GUI and their counterparts in the physical world, there is limited compatibility at best, and incompatibility at worst.

UI to Manipulate Deep Structure — Low
The underlying structure of complex graphical scenes and objects does not generally lend itself to effective graphical representation, that is, in terms of actions that you want to perform on it. While I may "know how" to manipulate things in the micro sense (point and click) I still may have problems achieving my goals in a macro sense. Consider Alias|Wavefront's *Maya* animation package [9], as an example. In this application, 3D geometry is available to the user in a number of representations. One is a 3D perspective view. Another is as a 2D dependency graph which reflects the deep structure of the graphics. Users are able to manipulate the graphics within this view. However, while this exposes the internal representation to the user in a form that can be manipulated, actually doing so can still be quite cumbersome.

This is sometimes due to a notational issue: the graphical representation or interaction techniques available may not be appropriate to the task at hand. Other times, however, it is due to the data itself being structured in a way that is incompatible with the manipulation that the user wants to perform (even though it was likely that same user who structured it that way.)

The former notational issue can often be addressed by offering another form of representation and manipulation. This is partially why packages such as Side Effects *Houdini* and *Maya* still support procedural scripting in addition to the GUI: this enables the user to manipulate the geometry and perform global, large scale manipulations at a variety of granularities. This scripting ability is more akin to the previous APL example than direct manipulation.

The latter point, the compatibility of the underlying structure itself to the types of manipulations that the user wants to perform is addressed by, and motivates, Example 3, below.

UI to Manipulate Surface Structure — High
There is a high compatibility between the GUI and the ability to manipulate the surface structure of the graphics. This is because it enables the artist to work directly on an image or 3D model. Note that this is not always done. Rather, almost more often than not, intermediate dialog boxes are used to manipulate parameters resulting in what might more properly be described as *indirect manipulation.*

Some work has been done to address this issue, such as building 3D manipulators and attaching them to 3D geometry [3]. Such manipulators provide efficient handles which afford control over key parameters of the underlying structure. They bring such control closer to the geometry itself than is the case with dialogue boxes, making control more direct.

In summary, GUI-based systems generally do a fairly good job of supporting the capability to work directly on the graphics. However, they also have affordances that bias and deter users from understanding the deep structure. Thus, users often have trouble manipulating the graphics at the appropriate level of detail or abstraction for the task at hand. The bias is towards the surface structure. Consequently, as the complexity of the (user created) graphical scene, object or animation increases, the effectiveness of the UI breaks down. Without a grasp of the deep structure and an effective handle on it, users are mired in too much detail, detail which becomes overwhelming regardless of how simple any single step of that detail is.

Resolving the Dilemma

Given these two examples, we are presented with a dilemma. How can we design interactive systems which maintain the balance of manipulability and compatibility over deep and surface structure? Already we have alluded to a hybrid approach (*Houdini* and *Maya*) which offers both scripting and direct manipulation solutions. But from the perspective of artists, direct manipulation is generally preferred since it is closer to how they work in the physical world. Consequently, intense scripting is typically delegated to a programmer (technical director) who is fluent in the scripting language.

What we would like to do in the remainder of this paper is discuss an alternative approach to finding a balance between control over the deep and surface structure of the graphics. This approach has more to do with how the user creates the graphics in the first place, rather than the mechanics of the UI per se. Here, one assembles the graphics using higher order primitives. The assumption is that much of the complexity in the deep structure in conventional systems stems from the primitives used being at too low a level. If the granularity of how one thinks about a model, for example, matches that of the primitives used to construct or modify it, then the assumption is that the underlying complexity for the user will be significantly reduced. Such primitives may be procedural or declarative. The key point is that they be compatible with how the user thinks, and that they afford control at the appropriate level of detail or granularity appropriate for achieving the user's goals. We will refer to this approach as *interactive assemblages.*

Example 3: Interactive Assemblages

I/O Compatibility — High
UI to Manipulate Deep Structure — Moderately High
UI to Manipulate Surface Structure — High

By interactive assemblages we mean the construction of graphical scenes, models and animations out of higher level components than is traditionally the case. Such components may be declarative (such as a canonical form or a generic skeleton with all of the IK handles and dynamics built in), procedural (such as a

Figure 1: Example of cloth simulation on a computer character [2]. **See page 103 for color image.**

Figure 2: Example of a flock of birds [10]. **See page 103 for color image.**

flocking module) or some hybrid of the two. Each integrates sophisticated behaviours or data into a single component having a manageable but rich set of appropriate operating parameters. These operating parameters, or handles, may be exposed to the user via virtual means (such as dialog boxes or 3D manipulators) or through physical means (such as specialized input devices like physical sliders, dials or customized graspable objects).

The deep structure now reveals the relationship among these components, rather than the low-level primitives traditionally used. Thus, there is an increased likelihood that any representation of the deep structure will be both more comprehensible to users, and afford manipulation at a level appropriate for the task at hand.

Let us describe three example modules to illustrate this idea: modeling cloth, specifying flocking behaviour and car design.

Modeling Cloth

Imagine animating a super hero who is wearing a cape. Specifying the behaviour of the cape through a sequence using keyframe techniques is as tedious as it is time consuming, so much so that the ability to experiment with different variations is extremely limited. On the other hand, if one has a generic parametrized cloth module (see Figure 1), the generation of such variations becomes relatively easy. First, one "dresses" the character. The artist does so at a high level, specifying parameters such as size, seams, fabric properties, texture and how tightly the material should fit or follow the character. The cloth module simulator then can calculate the behaviour of the cloth as the character moves — factoring in the physical dynamics of the cloth material and real-world properties such as gravity and object collisions. With this approach, notice that the specification of the character's movement is independent of the specification of the behaviour of the cape. Certainly the former affects the behaviour of the other. But unlike traditional animation, if I change the character's movement, I don't have to reanimate the cape, and if I change the material of the cape, I don't have to reanimate the whole thing. The animator addresses things at the appropriate level with the ensuing freedom to explore a far broader range of possibilities with relatively little increase in cost. In terms of the UI, one can imagine defining virtual or physical sliders and controllers to adjust the parameters of the cloth. Perhaps a set of instrumented pieces of fabric may facilitate specification of cloth behaviours. The idea is that the deep structure of the cloth module is abstracted and users only need to set a few high level parameters to get sophisticated behaviours.

Specifying Flocking Behaviour

A second example is the animation of the behaviour of a crowd of people, a school of fish or a flock of birds. Traditionally, one animates each member of the group individually. But if it is the character of the group as a whole which is of concern, one can offer this level of control (see Figure 2). First, the artist specifies a few representative characters, then specifies an area where the crowd should occupy. The flock module then populates the area with a random placement of instances of the representative characters. High-level parameters can then be defined which move the crowd in a particular direction, make them more or less active, and control the percentage of the crowd looking in a certain direction, etc. Again, it would be very tedious for the artist to have to manipulate each individual character within the crowd consisting of hundreds of characters.

Car Design

The previous two examples were procedural. Our third example involves a module that consists of declarative data. It is a car module in which the designer is presented with a canonical model of a car. This is in contrast with current practice where the designer starts with a blank sheet and works from there. The model contains and encapsulates the necessary engineering specifications and manufacturing constraints, as well as the essence of the "style" of that particular product line (see Figure 3). The notion is that by modifying the base model, rather than building each concept from scratch, one can work faster, stay within the style, conform to the engineering criteria and end up with a much better initial geometry.

Given these three examples, let us now consider the manipulation and compatibility issues of interactive assemblages.

I/O Compatibility — High

This approach builds upon the GUI and direct manipulation paradigm. However, since we are exposing more handles of the deep structure to modify, assemble and control the surface structure, we have a stronger opportunity to

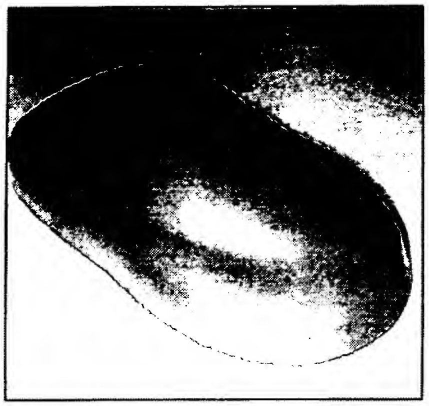

Figure 3: Example of a pre-fabricated base model of car. Model components compliments of General Motors. ***See page 103 for color image.***

manipulate these parameters using dedicated input devices. Thus, there are two main differences compared to the traditional GUI approach. First, the quantity of input is increased when we move towards offering multiple, dedicated physical input transducers for adjusting high level controls. This is in contrast to conventional GUIs having one graphical input device, such as the mouse, which serves as a "time-multiplexed" physical handle being repeatedly attached and unattached to a variety of logical functions of the GUI. Second, we shift to using more specialized form factors and capabilities for our input devices. These dedicated physical handles can serve as iconic input devices (physical icons) as well as graphical output.

UI to Manipulate Deep Structure — Moderately High

There is a moderately high compatibility with manipulating the deep structures. We are able to place direct manipulation UI on relevant parameters of the deep structures. These parameters are passed to procedural scripts or simulations which perform the real work. However, we are constrained by using only the parameters that are exposed to the user and by the components which are available for assembling. Nevertheless, we are now dealing with higher level components with meaningful handles.

UI to Manipulate Surface Structure — High

As with the GUI and direct manipulation example above, there is a high compatibility with manipulating the surface structure. Moreover, the user is augmented by the extensions mentioned above with the handles on higher level components. This gives users capabilities they would never consider doing by hand (e.g., adjusting each bird in a flock of 200 birds).

The results of these interactive assemblage components are a consequence of complex relationships among a number of variable parameters. For example, the cloth module may have 20 parameters to adjust to generate an enormous variety of cloth behaviour. Therefore it is not enough to understand the effect of changing one parameter but instead one needs to know the relationships among a set of parameters. The fundamental point is that having simultaneous manipulation through dedicated handles allows us to more effectively and rapidly explore these relationships (i.e., the parameter space).

There are at least three characteristics of the interaction that result from the interactive assemblages approach:

- Active exploration through the provision of rich control, including input handles (physical and conceptual) with good compatibility.
- A move from a "specification" to "exploration" style of interaction. The goal is to create a fertile ground for exploration but also to provide rich points of departure rather than starting from nothing.
- The exposure of portions of the deep structure at a high-level of abstraction. This allows users to leverage off of the deep structure using traditional GUI elements without as much of a need for an expert understanding of the micro level of the internal structure.

The net result is to place a manageable and compatible handle both physical and cognitive on the task of creation in this space.

Conclusions

In UI design we want to manage complexity through the use of structure. Today our elementary building blocks are at a very fine granularity and the onus is on the user (artist) to deal with the high overhead of creating, manipulating and managing structure from these atomic elements.

Our belief is that a significant part of the complexity of current systems lies within the structure of the data created by the user rather than in questions like "what does this button do?" The problem is, when building from scratch, one often doesn't know what structural features are needed until long after decisions have been made which make changing that structure, or working within it, overly difficult, expensive or even impossible. We see the same thing in software engineering where it often takes us multiple iterations to get our data structures correct. In this paper we have argued that we can address these problems for our users in much the same way we have dealt with them for ourselves: increase the granularity of the building blocks and shift the balance from a "creation" approach to one of "clone, modify and assemble."

There is a potential for strong tension between manipulating the surface and deep structure when there is a UI or representational discontinuity between the two structures. One step towards alleviating this is to display both structures and show how the deep structure changes as one manipulates the surface structure. Thus, users can build an understanding (perhaps limited) of the deep structure. Alternatively, we want to strategically migrate deep structure up to the surface. We suggest defining interactive assemblages as a way of bridging the gap between these two structures. The assemblages encapsulate the deep structure and offer high level control and handles within the same UI representation of the surface structure.

The key is to focus on manipulation and transformation rather than creation from scratch. Further, we want to manipulate relationships, both temporal and spatial, rather than individual parameters. Graspable systems should expose the deep and surface structure through the use of cognitive and physical handles of control.

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Figure 1: "Compatability and Interaction Style in Computer Graphics" by George W. Fitzmaurice and Bill Buxton. See pages 64-68.

Figure 2: "Compatability and Interaction Style in Computer Graphics" by George W. Fitzmaurice and Bill Buxton. See pages 64-68.

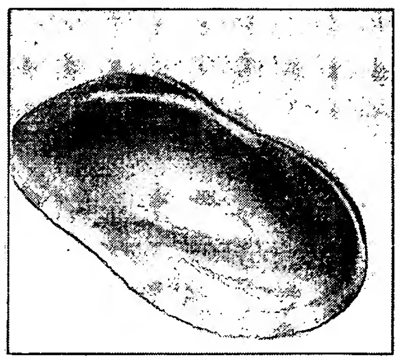

Figure 3: "Compatability and Interaction Style in Computer Graphics" by George W. Fitzmaurice and Bill Buxton. See pages 64-68.

Exploring Interactive Curve and Surface Manipulation Using a Bend and Twist Sensitive Input Strip

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Abstract

We explore a new input device and a set of interaction techniques to facilitate direct manipulation of curves and surfaces. The input device, called **ShapeTape™**, is a continuous bend and twist sensitive strip that encourages manipulations that use both hands and, at times, all 10 fingers. We explore this input and interaction design space through a set of usage scenarios for creating and editing curves and surfaces as well as consider general interactions such as command access and camera controls. This investigation is carried out by extending **Alias|wavefront's** modeling and animation package, Maya.

CR Categories **and Subject** Descriptors: H.5.2 [Information Interfaces and Presentation (e.g., HCI)]: User Interfaces - Input devices and strategies, Haptic I/O, Interaction styles; I.3.3 [Computer Graphics]: Picture/Image Generation - Line and curve generation; I.3.6 [Computer Graphics]: Methodology and Techniques - Interaction techniques.

Additional Keywords: Input devices, bimanual input, ShapeTape, interaction techniques, gestures, curves, surfaces, 3D modeling.

1 INTRODUCTION

In 3D computer graphics modeling, curves are the quintessential primitive for constructing and manipulating surfaces. Successful 3D modelling is largely based on producing the right set of curves which ultimately give rise to the desired 3D shape. Thus, techniques for developing and controlling curve shapes are a critical issue.

Most current interactive curve manipulation techniques require that the user, to some extent, work with the mathematical definition of a curve to control its shape. For example, curves are created and controlled by virtual techniques such as control vertex positioning and adjusting curve continuity and tangency.

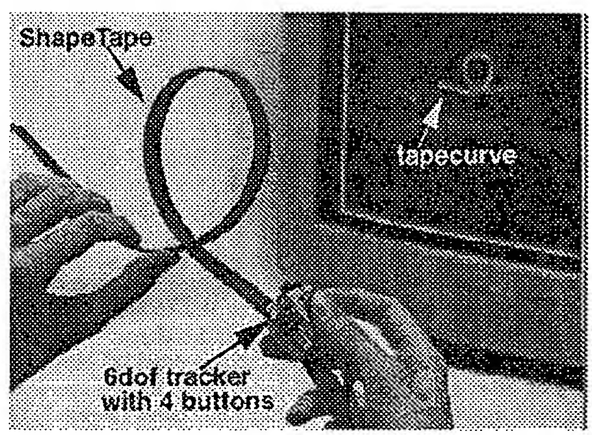
In the design industry, traditional physical techniques such as clay modeling and paper drawings are still very popular. In these techniques, the curve itself is manipulated directly by copying preshaped physical curves (e.g., french curve templates) or using physical tools which flex to produce curves (e.g., flexible steels).

Because virtual manipulation and physical manipulation of curves are so different, a designer's physical modelling skills do not wholly transfer to virtual modelling. For example, a designer can express a particular shape using a flexible french curve by simply bending the french curve. However, with a virtual curve it may not be clear how the control vertices need to be placed to attain this shape.

Certain physical objects can also quickly produce curves and surfaces that are hard to create using virtual techniques. For example, the affordances of spring steels are exploited by clay autobody sculptors who use large spring steel rulers, flexed into shape using both hands, to smoothly sweep out a curved surface on clay.

Obviously, both virtual and physical curve modelling have their own pros and cons. What we are interested in is exploring the idea of combining virtual and physical curve creation and control techniques. The key element in our ability to combine these two worlds is a unique input device called **ShapeTape™** (Figure 1) [8], which allows users to directly manipulate a virtual curve as a physical object. Our combined interaction style is inspired by our previous example of clay autobody sculptors using steels to sweep out curved surfaces.

In this paper, we explore the use of ShapeTape for performing some basic curve and surface creation and manipulation operations. We present a prototype system we have built to serve as a framework for this exploration. This exploration differs from previous non-conventional modeling paradigms [7, 10, 12] in that we use ShapeTape to directly control modeling curve primitives. We describe the set of interactions that we implemented within this framework and our observations and issues with these interactions. We then discuss how these specific issues generalize to other domains and devices.



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2 SHAPETAPE

ShapeTape is a 48 x 1 x 0.1 cm rubber tape that senses its bend and twist. Bend and twist are measured at 6 cm intervals by two fiber optic bend sensors. Resolution is limited by the spacing of these sensors. By summing the bends and twists of the sensors along the tape, the shape of the tape relative to the first sensor can be reconstructed. We sampled all 16 sensors along the tape at 30Hz.

3 APPLYING SHAPETAPE TO MODELING

Our prototype system is built within Aliaslwavefront's 3D modeling and animation application, Maya. Maya ran on a Silicon Graphics Indigo2 workstation.

We use ShapeTape to control NURBS curves within Maya. A one to one mapping was used between the Shapetape and a NURBS curve – changing the shape of the ShapeTape resulted in an identical change to the NURBS curve. This was implemented by mapping the shape segments along the ShapeTape to a subset of the control polygon of a NURBS curve. The rotation samples simply map to the control vertex sequence such that: $\mathbf{P}_{i+1} = \mathbf{P}_i + \mathbf{L}*\mathbf{R}_i$, where $\mathbf{P}_i$ is the position vector of the i^{th} control point, $\mathbf{R}_i$ the i^{th} rotation matrix and L a vector representing segment length between samples. $\mathbf{P}_0$, $\mathbf{R}_0$ is given by the position and orientation of the first sensor on the ShapeTape in 3D space (we describe how this is obtained in the next section). For most applications we would like the mapped curve to be planar. $\mathbf{R}_i$ is constructed from the bend samples in this case and is simply the rotation matrix for the bend corresponding to the sum of all bends from 0..i. Incorporating the twist samples into the calculation of $\mathbf{R}_i$ is straightforward.

3.1 Augmenting ShapeTape

To create and manipulate curves in a 3D scene we need more than the ability to simply input the shape of a curve. We need to support operations like command execution, camera controls, and positioning/orienting the entire curve in 3D space. Since ShapeTape requires and benefits from using both hands and all fingers to operate it, we felt that it would be unwieldy to rely on the status-quo mouse/keyboard for these secondary functions since this would require that the user release their hold on the tape. We therefore augmented ShapeTape so that secondary functions could be performed while both hands manipulated the tape. Another approach would be to design the interactions such that the ShapeTape could be picked up and put down. However, we were interested in the more extreme design of trying to accomplish everything while holding the shape tape. Alternative designs are discussed later in the paper.

To position and orient the curve in 3D space, we attached a 6 degrees-of-freedom (dof) tracker (an Ascension Flock of Birds) to the starting point of the tape (Figure 1). The tape and the virtual curve it controls (we call this the "tapecurve") then operates relative to this starting position.

All our interactions were designed to operate in a perspective view and, therefore, users need to at least be able to tumble the virtual camera to get both depth perception and different views of the curves/surfaces they were working on. We provided camera controls by using a 2-dof custom designed puck that was operated by the user's right foot on a Wacom digitizing tablet (Figure 2). This "footmouse" had a single button on it that allowed the user to switch to camera tumble mode and tumble the scene by stepping

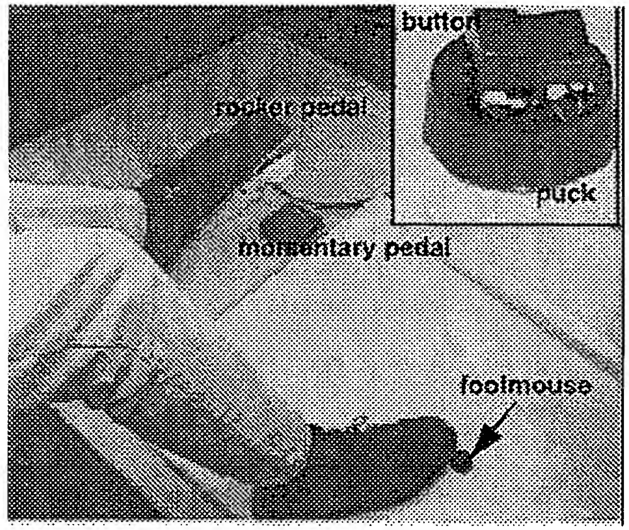

Figure 2. Foot pedals and footmouse. Inset picture is a closeup of the custom designed footmouse puck

on the footmouse and moving it around on the tablet. Since the scenes we were working with were not very complicated, we felt that tumbling was a sufficient camera control. Other camera operations such as pan, dolly, and zoom were not implemented in our prototype.

We added four pushbuttons to the 6-dof tracker to provide for command execution and clutching of the tracker (Figure 1). The buttons were chosen and arranged on the tracker such that accidental triggering was minimized and more than one button could be pressed at the same time.

Using the tracker buttons requires one hand to be at the end of the ShapeTape which reduces the user's ability to manipulate the shape of the ShapeTape itself. To somewhat alleviate this problem, we used two footpedals (a rocker pedal and a momentary pedal) operated by the left foot for additional button input that could be operated while the user used both hands to shape the curve (Figure 2).

We now discuss several interaction techniques we have implemented based on this input configuration to explore the creation and modification of curves and surfaces.

3.2 Interaction Techniques using ShapeTape.

In a manner similar to most 3D modeling packages we implemented various curve and surface manipulation functions as temporal modes (commonly called "tools"). We did not implement a technique for switching between the different tools. As a stop-gap measure, we rely on the keyboard to do this. Ideas for supporting tool switching seamlessly in our system are discussed in a later section.

In each of our tools, the following footpedal and button assignments were used. Tables 1 and 2 summarize these assignments.

When the rocker pedal was up, the tracker was operational and the tapecurve could be positioned and oriented in 3D space. We call this "position/orient tapecurve mode". In this mode, buttons 1, 2, and 3 engage and clutch movement along the x, y, and z axes respectively. Chording buttons 1, 2, and 3 allowed movement in multiple axes simultaneously (e.g., pressing both buttons 1 and 2, engaged movement in the plane defined by the x and y axes). Button 4 was used as a toggle to enable and disable all three rotational degrees-of-freedom of the tracker.

Device	Limb	Function
rocker pedal	left foot	up: position/orient tapecurve mode down: command mode
momentary pedal	left foot	toggle between freezing and unfreezing shape of tapecurve
footmouse	right foot	tumble camera
ShapeTape	both hands	control shape of tapecurve
tracker	right hand	control position and orientation of tapecurve
tracker buttons	right hand	command access and tracker constraints (see Table 2)

Table 1: Functionality of devices

tracker button	position/orient tapecurve mode	command mode
button 1	constrain to x axis	next step in tool
button 2	constrain to y axis	end tool
button 3	constrain to z axis	
button 4	rotation on/off	

Table 2: Tracker button assignment

When the rocker pedal was down, the tracker was disengaged and the tracker buttons could be used to execute commands. We call this "command mode". Button 1 was always used to activate the next step in the tool currently being used. Button 2 signals completion of a tool's operation and resets the tool to its initial state (this allows a tool's operation to be repeated without having to reinvoke the tool). Buttons 3 and 4 were used for commands specific to particular tools, which we describe later.

The footmouse and momentary pedal were independent of modes and thus could be used at any time.

3.2.1 Curve Creation

The first tool we explored allows the creation of curves in 3D space. As described earlier, the shape of the tapecurve was controlled by the ShapeTape and its position and orientation controlled by the tracker.

At any time, the momentary pedal could be depressed to freeze the shape of the tapecurve. Depressing the momentary pedal a second time unfreezes the shape of the tapecurve. This concept of freezing/unfreezing the tapecurve shape using the momentary pedal is used throughout our different interaction techniques. Note that the tapecurve can still be positioned and oriented in 3D space when its shape is frozen.

When in command mode, pressing button 1 resulted in a snapshot copy of the tapecurve being placed in its current location and orientation. We refer to this as "baking" the tapecurve into the 3D scene. Note that we can bake the tapecurve either when it is live or frozen.

We found this technique to be intuitive for creating free-form 3D curves and it allowed for quick exploration and specification of curve shapes, position, and orientation.

While the position and orientation of the tapecurve can be controlled fairly precisely using our methods for constraining movement to particular axes, it was difficult to precisely control the shape of the tapecurve. Borrowing from the physical tools used by designers, we investigated using physical constraints to improve control over the shape of the tapecurve.

One form of physical constraint is to attach spring steels to ShapeTape. Using steels of different thicknesses and degree of flexibility (Figure 3a), we can vary the deformability of ShapeTape and, in a sense, physically control the smoothness and curvature of the tapecurve. Using small strips of velcro on the ShapeTape and the steels, we are able to switch between different steels easily. One characteristic of spring steels is that they have to be continually held in the desired shape and do not retain the deformed shape when released. While this can be a desirable feature when exploring shape, it can be a shortcoming when trying to maintain a particular shape for a period of time. To address this shortcoming, we devised a jig (Figure 3b) that allowed us to mechanically hold the spring steel in a deformed shape. Once the desired shape is obtained, the wingnuts on the jig are tightened and the entire jig (and resulting tapecurve) can be positioned and oriented as

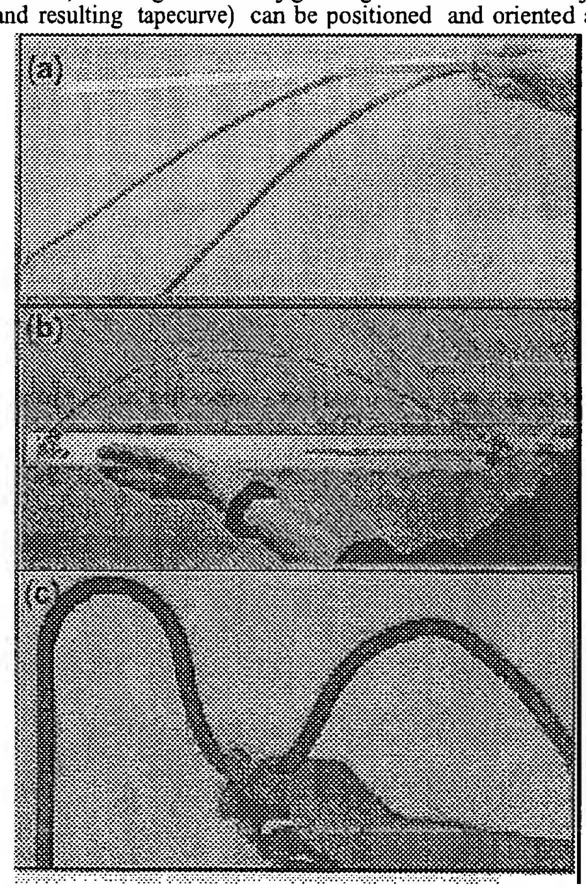

Figure 3. (a) Spring steels of different thicknesses and flexibility. (b) Jig for constraining spring steel. (c) Flexible curve that retains its deformed shape.

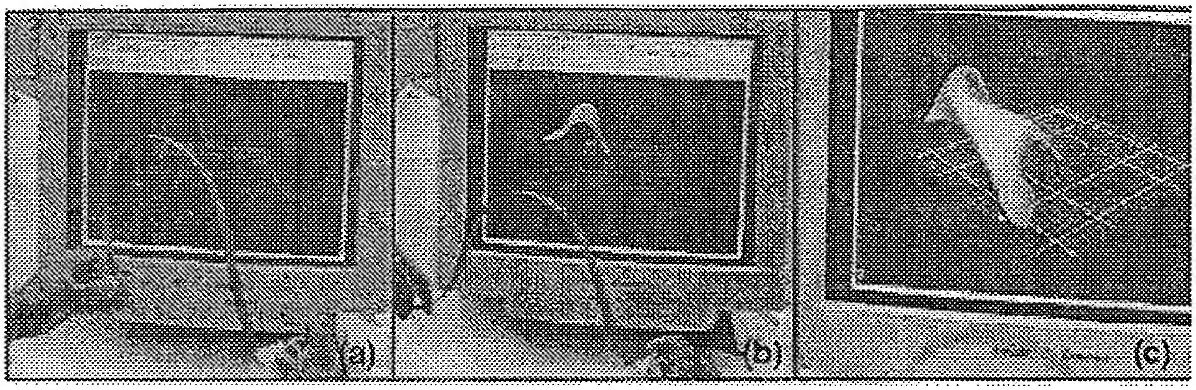

Figure 4. Loft. (a) Placement of initial profile curve. (b) Dragging out first section of the lofted surface. (c) The final surface lofted over five interactively placed profile curves.

required. Position and orientation of the jig can also be physically constrained in a variety of ways. Examples include simply dragging the jig on a tabletop to constrain movement to a plane, or mounting the jig within a larger jig that imposes some other positional or rotational constraints.

The last form of physical constraint we explored was the use of flexible curves (Figure 3c). These curves, used in the design industry, do not provide the high level of smoothness that spring steels offer but retain their deformed shape when released. They are a good compromise when smoothness is not an important factor.

The use of steels, jigs, and flexible curves have the advantage that the user can easily switch between these different constraints and leverage off their existing knowledge of the physical world when learning to use these tools. These advantages have been expounded by Fitzmaurice et. al. [3] in their Graspable UI paradigm, by Ishii et. al. [4] in their Tangible UI research, and by Hinckley et. al [5]. However, one disadvantage is that we also inherit all the limitations of the physical world. Since we haven't yet implemented virtual solutions to address these limitations, we defer the discussion of these solutions to a later section of this paper.

Given the ability to interactively create 3D curves using ShapeTape, we now describe three techniques for creating surfaces interactively from these curves.

3.2.2 Loft

"Loft" refers to the construction of a surface that passes through a series of profile curves. The status-quo interaction technique requires that at least two profile curves be predefined before a surface can be lofted over them. Additional curves can then be added to extend the lofted surface.

Using ShapeTape, our "loft tool" creates surfaces as follows: first, we use ShapeTape to bake the initial profile curve (Figure 4a). Then, we press button 1 in command mode to create a lofted surface from the initial profile curve (cl) to the tapecurve. Since the tapecurve is still "live", the user can dynamically change the shape of the lofted surface segment in real time (Figure 4b). Pressing button 1 in command mode again bakes the tapecurve, resulting in baked curve c2 and a baked surface from curves cl to c2. A new live surface is then lofted from curve c2 to the tapecurve. This process can be continued to successively extend the lofted surface. Once the final surface is obtained, button 2 is pressed and the tapecurve is detached from the final lofted surface (Figure 4c).

Thus, this technique allows users to "drag out" a surface starting from the initial profile curve, baking sections of the surface as desired. The ability to manipulate the current surface segment in a live manner allows the user to preview and explore variations of the forthcoming surface before baking it. In contrast, the status quo interaction technique requires the user to lay down a series of curves and then loft a surface across those curves. No preview of the resulting surface is given, and any changes have to be made in a post-creation process.

The physical constraints we explored in the previous section can also be used here to constrain the tapecurve and thus create the smooth controlled surfaces that are typically used in non-organic technical modeling.

3.2.3 Revolve

"Revolve" refers to construction of a surface by revolving a profile curve about a given axis.

In our "revolve tool", we first specify the profile curve using Sha-

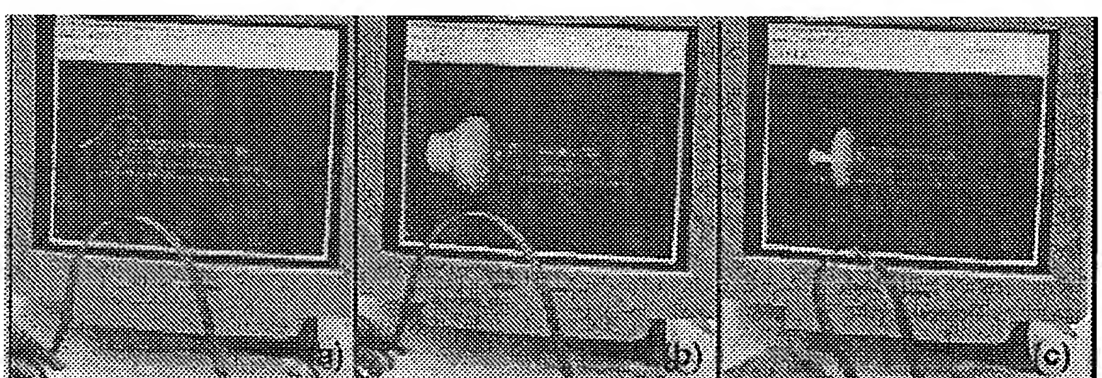

Figure 5. Revolve. (a) Placement of initial profile curve. (b) Revolving the profile curve about the x-axis. (c) The revolved surface can be interactively manipulated to explore different shapes, positions, and orientations.

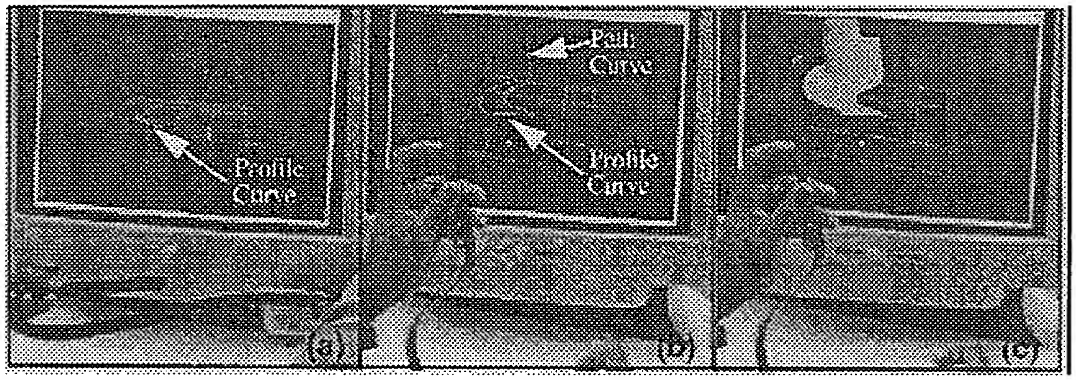

Figure 6. Extrude. (a) Placement of profile curve. (b) Placement of initial path curve. (c) The extruded surface can be interactively manipulated to explore different shapes, positions, and orientations.

peTape (Figure 5a). This curve can either be frozen or live. Then, we press button 1, 3, or 4 in command mode to revolve the profile curve about the x, y, or z axis respectively (Figure 5b). Since the profile curve is still controlled by ShapeTape, the resulting surface can therefore be manipulated in a very interactive manner to explore different shapes, positions, and orientations (Figure 5c). Button 2 can be pressed at any time to complete the revolve operation which bakes the revolved surface.

In status-quo revolve techniques, the resulting revolved surface can only be manipulated by moving control vertices of the profile curve or by translating, orienting, or scaling the entire curve. While this is fine for small modifications, it does not provide the sense of engagement or expressiveness of the ShapeTape technique. On the contrary, ShapeTape in its current configuration does not easily support precision adjustments to the surface.

3.2.4 Extrude

"Extrude" refers to constructing a surface by sweeping a cross sectional profile curve along a path.

In our "extrude tool", we first specify and bake the profile curve (Figure 6a) by pressing button 1 in CommandMode. Then, the tapecurve is used to specify the path curve (Figure 6b). This curve can either be frozen or live. Pressing button 1 again creates an extruded surface by sweeping the profile curve along the path curve (Figure 6c). Since the path curve is still controlled by ShapeTape, the extruded surface can now be manipulated interactively. Button 2 can be pressed at any time to bake the extruded surface and detach the tapecurve from it.

As with the Revolve example, the ShapeTape extrude technique allows for more expressive manipulations of the surface than the status-quo interaction technique. However, our technique currently allows interactive manipulation of the surface only by controlling the path curve, not the profile curve. We plan to develop techniques to dynamically select which curve ShapeTape controls.

3.2.5 Surface Deformations

The previous tools permit the creation of surfaces. We now discuss techniques for deforming existing surfaces of arbitrary shape. We use ShapeTape to manipulate "wires" – a geometric deformation technique based on space curves [11]. This application also highlights the use of the ShapeTape's twist capability.

A wire is a curve whose manipulation deforms the surface of an associated object near the wire curve. The deformations to objects are based on the relative deviation between the wire curve and its corresponding reference curve (Figure 7a). The reference curve is a congruent copy of the wire curve made when objects are associated with it. An appealing attribute of wires is that not only do they

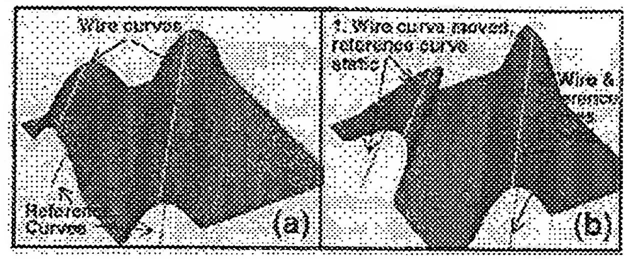

Figure 7. Wrinkles and creases using wires. (a) Shows two wire curves and associated reference curves deforming a surface. (b) 1. If a wire curve is moved while its reference curve is static, the wrinkling effect is increased. 2. If a wire curve is moved along with its reference curve, the wrinkle travels along the surface.

utilize the bend of the curve, but they also embody the notion of twist around the wire curve and impart it to the surfaces they deform. We thus are able to use the twist of the ShapeTape to directly control the twist along a wire curve. The effect of twisting the ShapeTape is thus manifested as a surface deformation even though it is not visually represented on the wire curve.

Our "wire tool" provides three styles of interaction to deform surfaces with wires. In all three styles, we attach a wire curve to a surface to be deformed by pressing Button 1 in Comma&Mode. Pressing Button 2 in CommandMode detaches the wire from the surface. Button 3 is used to change between the three styles of interaction.

In the first style, ShapeTape controls the bend, position, and orientation of the wire curve while the reference curve remains static. This allows for creasing deformations to be created as illustrated in Figures 7b(1) and 8a,b.

The second style operates in the same manner as the first style except that the reference curve is translated along with the wire curve. This allows for "travelling" wrinkle deformations as illustrated in Figure 7b(2).

The third style uses twist in addition to bend, position, and orientation to control the wire curve. Adding twist further deforms the crease and wrinkle deformations in a manner similar to pinching (Figure 8c).

Wires are a deformation technique originally designed to create organic surfaces like cloth and skin. We found that using ShapeTape with wires allowed for deformations of surfaces that would be very difficult to specify with traditional tools for manipulating wires. Like our surface creation tools, the ability to quickly explore different deformations effects allowed for more expressive manipulation than the control vertex positioning status-quo techniques.

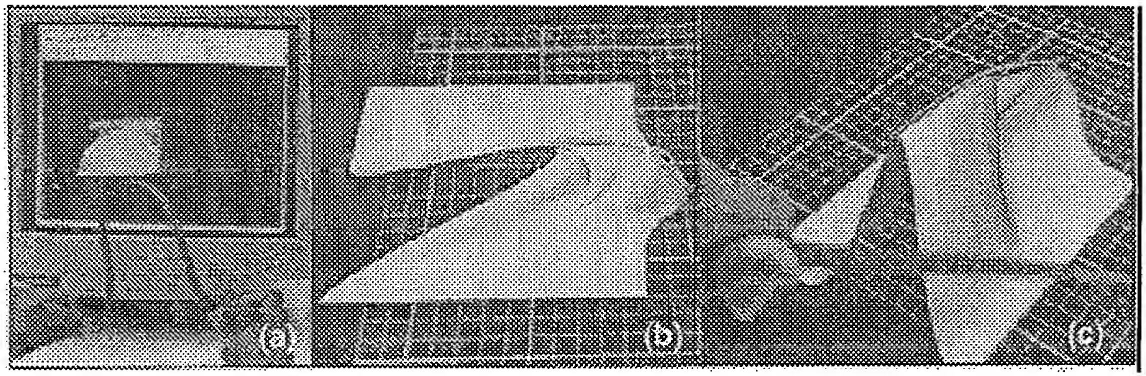

Figure 8. Surface deformations using ShapeTape. (a) Bend of wire curve deforming a surface. (b) Bend and position of wire curve deforming a surface. The reference curve is static. (c) Twist of wire curve deforming a surface.

4 FURTHER ENHANCEMENTS

There are several ideas which, although we have not implemented, we feel are important in continuing to develop our ShapeTape prototype.

ShapeTape subsection specification – The ability to specify subsections of the ShapeTape would be useful. For example, suppose a user is happy with the shape of one half of the tapecurve but wishes to modify the other half. Sensors along the length of the ShapeTape could be used to specify which subsections are active, thus limiting changes to the corresponding parts of the tapecurve. Possible sensing technologies include binary microswitches and pressure sensitive strips.

ShapeTape to tapecurve mappings – An important issue is the control mapping between the ShapeTape and the tapecurve. In our prototype a one-to-one mapping was used where the unit length of the ShapeTape mapped to the unit length of the tapecurve with a constant gain. The ability to modify this mapping would be valuable. For example, the entire ShapeTape could be mapped to a subsection of the tapecurve, allowing finer control over that portion of the tapecurve. Subsections of the ShapeTape could also be mapped to subsections of the tapecurve in a non one-to-one manner. Editing of existing curves in a scene could be achieved by selecting a subsection of a curve and mapping it to a subsection of the tapecurve. This section of the virtual curve could then be edited by the ShapeTape.

Increasing/decreasing control gain – The control gain of the ShapeTape could also be modified. For example, by increasing the control gain ratio, small ShapeTape bends could translate into larger bends in the tapecurve. This could be used as a convenience mechanism to reduce physical movement. In contrast, the gain ratio could be decreased and this would result in more precision control over the bends of the tapecurve.

Non-uniform control gain – Varying the gain ratio over the unit length of the ShapeTape may also be a useful mechanism. Mappings could be devised where the ShapeTape is much more sensitive (or insensitive) over certain sections of the shape. This could be used to create curves which when bent have a pre-bias towards a certain shape.

Frame of reference – As the scene rotates (i.e., when the camera is manipulated) should the tapecurve remain stationary in user space (ego-centric) or turn with the scene (scene-centric)? If the tapecurve follows a scene-centric model, this will sometimes produce a stimulus response mismatch between movement of the ShapeTape and movement of the tapecurve. However, if the tapecurve follows an ego-centric model, this too can lead to problems since moving the scene then in effect moves the tapecurve relative to the scene. For example, if the tapecurve was being used as a deformer, unwanted deformations would occur when the scene was rotated. While we have some ideas for solutions to these problems, they have not been sufficiently explored.

Additional command access – While working with ShapeTape, we found it necessary to provide a way to switch between tools. There are many possible solutions to explore here. First, we could add additional push buttons to the tracker or introduce more foot pedals. This solution is not very attractive as the tracker is already crowded with buttons. Introducing more foot pedals may be problematic as the user must search for the proper fool pedal, diverting their attention from the 3D scene. Second, we could use speech and voice recognition to specify commands. Third, we could create a set of ShapeTape gestures that would map to commands. Here the challenging issues are being able to define meaningful shapes that match their assigned command and finding good gesture and shape recognition algorithms. Also, we'll have to toggle the ShapeTape between specifying command gestures and controlling the tapecurve. Last, we could add a series of pressure sensors along the length of the tape. These pressure sensors could be used as a button strip for command control buttons. One limitation of this idea is that these buttons cannot be used while simultaneously specifying a shape since pressing will deform the tape (for example, the "freeze" command would be a poor choice). While some of these ideas may result in a good solution, the problem of providing additional command access remains an open issue.

GUI access – Beyond command access, the ShapeTape device could work in conjunction with standard GUI elements by driving the cursor. This would allow us to use standard GUI widgets like graphical buttons, sliders, and menus for operations such as tool switching without having to put down the ShapeTape. This could be done by tracking the location of the end of the ShapeTape relative to the screen and mapping this to a cursor location. The foot pedals could be used for simulating mouse buttons. Alternatively, button presses could be simulated when the tape endpoint is moved in or out a fixed distance from the screen.

5 GENERAL OBSERVATIONS

Our experiences so far have lead us to some general observations about this style of input and these types of interaction techniques. Below we outline our findings and how they are relevant to other application domains.

High dimension input-We consider ShapeTape to be in a class of input devices we call High (High dimension input). Roughly speak-

ing, HiD devices are devices or arrangement of devices which allow simultaneous input of more than 3 degrees of freedom. Systems like the monkey armature [6], dataglove [2] and haptic lens [9] are examples of HiD devices. In many ways, this paper explores issues in harnessing HiD input. We believe that there are issues common to most HiD input configurations. We now discuss what we believe to be the major issues.

Regulating Input – HiD devices require the ability to regulate the input. Mechanisms are needed for easily engaging and ignoring sets of input dimensions. For example, in our prototype, we found the need to freeze the 3D position, 3D orientation, and shape of the input curve. These mechanisms could be provided in either or both the virtual or physical mediums.

Need for other independent devices – In our prototype, we made use of auxiliary devices to assist in regulating the input from our HiD device (e.g., using a footpedal to freeze the tapecurve) or for interface control (e.g., a footmouse to tumble the camera view). In general, auxiliary devices are needed if a regulating or interface action interferes with control of the HiD device. For example, there was a need to be able to hold the shape of the tapecurve and at the same time trigger a "freeze" action. Note that employing the use of other limbs is a common practice in other HiD domains. For example, guitar and piano players use footpedals to select playing modes and effects while playing.

Input retention – Rather than requiring a user to "hold" a particular setting of a HiD device, a device could be built such that it retains its settings. For example, by attaching ShapeTape to jigs or flexible french curves (Figure 3), we created the ability for the ShapeTape to retain its settings. Removing the requirement of constantly holding the device frees the hands to operate other devices such as the mouse and keyboard. This may allow more standard UI techniques to be used to support regulating and auxiliary functions.

Interdependence and quality of input dimensions – A simplifying but sometimes confounding factor to consider in HiD input is the interdependence of input dimensions. Consider ShapeTape – while there are a total of 16 sensors, and thus 16 degrees of freedom, it is difficult to actuate one sensor in isolation. In fact, the user perceives the ShapeTape as a single malleable input strip. They judge the quality of the input based on how quickly and accurately the virtual shape matches the physical input shape. This directly corresponds to the quantity and quality of the sensors as well as the physical material properties of the ShapeTape.

Sense of engagement – HiD input can offer a greater sense of engagement and expression compared to traditional lowD input (e.g., mouse) which often emphasize specification and precision. With HiD input, precision can be temporarily attained by reducing the input dimensions being sensed, by using physical/virtual constraints, and by varying the control gain. In contrast, there is no easy way to improve the sense of engagement with lowD input. 3D graphical manipulators [1] are one technique for providing a greater sense of engagement but this still offers limited expressibility.

Control skill demands – HiD input may place a higher demand on the user's motor and cognitive processes. Users are required to attend and monitor many streams of simultaneous input. This is especially true for precision work. We believe that cognitive and motor demands may be reduced when: (1) the physical device closely matches the virtual representation, (2) the input device allows the high dimensions to be coordinated in a familiar metaphor (e.g., the ShapeTape bend and twist sensors are aggregated in a single strip), and (3) the interaction techniques allow for constraining input through other input streams (e.g., tracker buttons constrain movement along the x, y, and z axes).

Disadvantages of physical representations – While the ShapeTape offers physical manipulation of an input strip this approach is susceptible to the constraints of the physical world. For example, any given ShapeTape has certain bend properties which are invariant. In addition, having customized input devices attached to a given system makes it difficult to move to another workstation. This is in contrast to virtual tools being available on any system. Physical tools are also subject to the "nulling problem." This problem occurs when the physical state of the device starts out matching the virtual representation but becomes stale as the virtual state changes without keeping the physical device consistent. This nulling problem can often be alleviated by operating the physical device in relative mode instead of absolute mode.

"Iron horse effect" – In general, a major design issue for HiD input is the danger of mimicing properties of the analogous physical tools too closely. That is, replicating not only the advantages of a physical tool but also its disadvantages (the iron horse effect – some of the first automobiles were not only controlled like a horse but also shaped like one). Avoiding the iron horse effect requires carefully determining exactly what ability a physical tool offers versus what is merely an artifact of physicality.

6 FUTURE RESEARCH

There are a number of issues relating to ShapeTape that need to be further explored:

- Our current prototype paradigm has ShapeTape as the primary input device, always in hand, but alternative input configurations with different costs and benefits are possible. For example, one alternative has the ShapeTape operating on a 2D surface where the contour of the tape is sensed as an input curve but the location and orientation of the curve is managed through more traditional interaction techniques (i.e., manipulators) with the mouse. The benefits of this configuration is that the tape does not need to be continuously held and a 6dof tracker isn't required.
- We would also like to consider the use of two or more ShapeTape devices to form a shape sheet. This would allow one to directly manipulate surfaces.
- While we were happy with the performance of the footmouse and foot pedals, we believe that additional design can be done to improve their usage.
- In addition to using ShapeTape for modeling, we would like to explore other application domains such as animation. Here the ShapeTape could be used to specify motion paths, adjust timing curves, motion capture, or for quickly editing and posing characters and deformable objects like cloth.
- Finally, we would like to consider if any of the interaction techniques will transfer to other two handed input configurations. For example, one could imagine a "poor man's" ShapeTape. Rather than using ShapeTape, two devices such as two pucks on a digitizing surface or two 6dof trackers could be used. A virtual curve between the two devices could be inferred given their positions and orientations.

7 CONCLUSIONS

The one-to-one mapping between Shapetape and a NURBS curve allows for great ease of use and learning. For example, the manner in which the shapetape controls the NURBS curve is immediately obvious. The fact that the underlying curve being controlled is a NURBS curve is completely transparent.

One dominating observation in our prototype was that ShapeTape imparts an expressive and live feeling to operations. Specifically it allows different shapes and effects to be quickly attained. This property is especially suitable for conceptual modeling – modeling done to allow a designer to quickly explore form, shape, and size.

ShapeTape at this point appears less suitable for technical modeling, which focuses on constructing precise curves and surfaces. To make ShapeTape more suitable, first, the precision of the shapetape itself would have to improve. Second, both physical and virtual ShapeTape specific modeling constraints and constructs would have to be invented and developed.

We believe we have discovered some fundamentals of the basic interaction framework and input configuration which is effective for managing the HiD input of ShapeTape.

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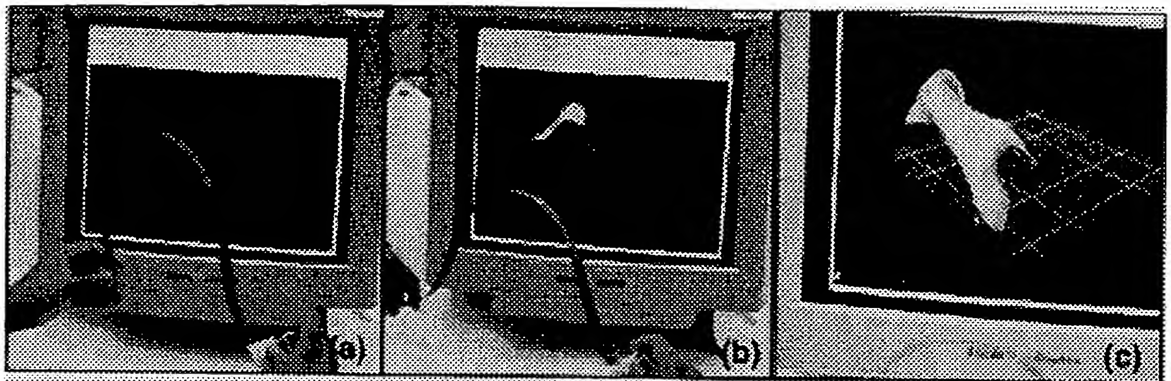
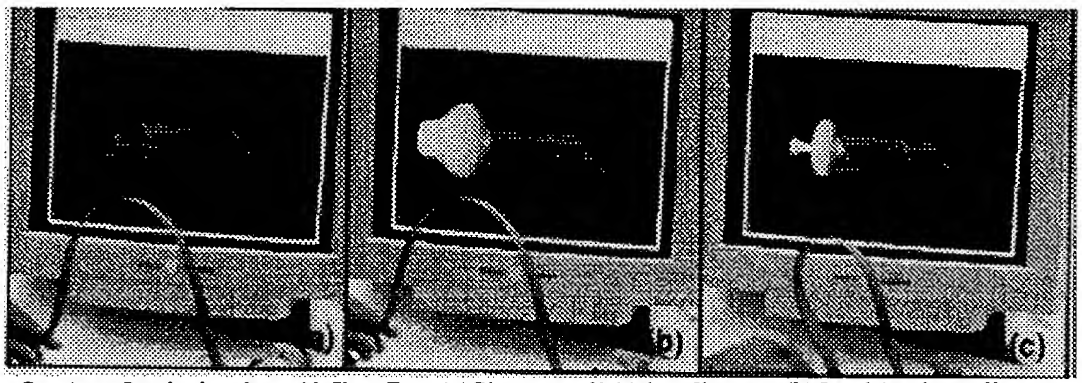
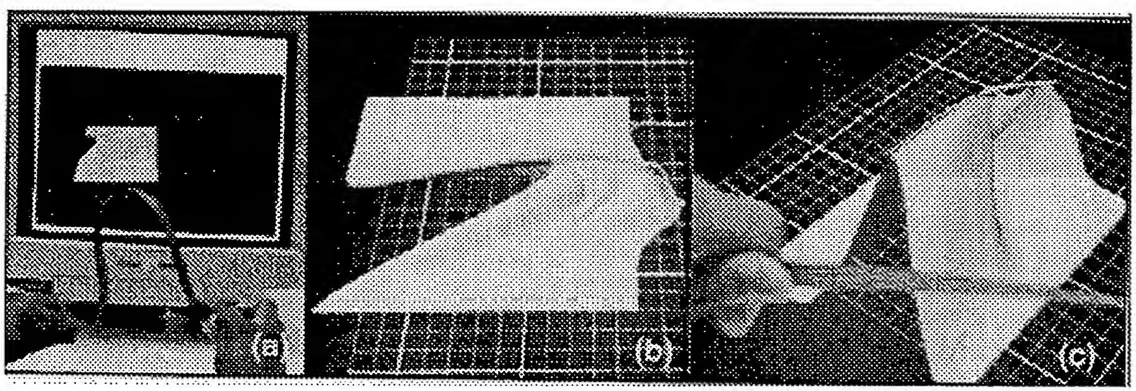


Lofting a surface with ShapeTape. (a) Placement of initial profile curve. (b) Dragging out first section of the lofted surface. (c) The final surface lofted over five interactively placed profile curves.



Creating a Revolved surface with ShapeTape. (a) Placement of initial profile curve. (b) Revolving the profile curve about the x-axis. (c) The revolved surface can be interactively manipulated to explore different shapes, positions, and orientations.



Surface deformations using ShapeTape. (a) Bend of wire curve deforming a surface. (b) Bend and position of wire curve deforming a surface. The reference curve is static. (c) Twist of wire curve deforming a surface.